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THE ROEBLING CONCRETE FLOOR, whose test by fire was described in our issue of Nov. 5, was subjected to a test load of 4,000 lbs. per sq. ft. on Dec. 11, by the Building Department of New York city. As shown in the report in our issue of Nov. 5, the floor forming the roof of a brick building, 12 × 16 ft. floor area and 12 ft. high, was made of 10-in. I beams, 25 lbs. per ft., spaced 4 ft. between centres, with concrete arches 3 ins. thick at the crown sprung across the space. The concrete was made of 1 part Aalborg Portland cement, 2 parts sand, and 5 parts ashes from steam boiler furnaces. A wood fire was maintained under this floor for five hours, during the last three of which it was held at over 2,000° F., and at the end of the time a stream of water from a fire engine was applied to the under side. During this test the floor sustained a load of 150 lbs. per sq. ft. On the next day the load was increased to 600 lbs. per sq. ft. without injury.

A test of the floor to destruction was determined upon by the builders. The test was begun on Dec. 11, and continued on Dec. 12 and 14. A section of the middle arch 4 ft. wide between the I beams, and 2 ft. 6 in. in length, making 10 sq. ft. area, was isolated from the remainder of the floor by cutting openings at each end of its length. On this section a brick pier 1 ft. high was built, and over it was placed a platform of heavy plank 7½ ft. square. This was loaded with brick and stone until 40,000 lbs. was supported by the loaded area of 10 sq. ft., or 4,000 lbs. per sq. ft., when the load became so top-heavy it was considered dangerous to continue the test further. The deflection of the center of the arch under this load was just one inch; after the load was removed it decreased to ⅝ in.

A TEST OF A CONCRETE FIREPROOF FLOOR constructed by the Columbian Fireproofing Co., 156 5th Ave., New York city, was made by the Building Department of the city at 68th St. and Avenue A on Dec. 23. The test was conducted in the same manner as the other tests that have been made by the department during the last four months, which have been described in our columns. The floor was loaded to 150 lbs. per sq. ft. and subjected to a heavy fire for five hours, and then suddenly cooled by a stream from a fire engine. The floor sustained its load throughout the test, the maximum deflection being about 3 ins. We shall give in next week's issue a more detailed account of this test, with a drawing showing the construction of the floor.

A LIMIT FOR THE HEIGHT OF BUILDINGS is demanded by the New York fire and health officials, in answer to queries submitted by the Committee of the New York Board of Trade and Transportation now investigating this subject. The Fire Department favors a limit of 85 ft., as provided for in the building laws. So-called fireproof buildings do not come under this law and some of them are 300 ft. high. Chief Bonner does not believe these buildings are fireproof, and said that when the height exceeded 125 ft. there should be an auxiliary fire plant on each floor handled by trained men. He recommended that no office building be more than 12 stories high for a street not less than 85 ft. wide; commercial buildings should not exceed 10 stories, with 70 ft. as a minimum street width; and apartment house 7 stories on a 60 ft. street. The Board of Health objected to high buildings from a sanitary point of view, stating that they restricted sunlight; they made artificial light necessary, and were difficult to supply with good water on the higher floors. Statistics were submitted showing that in all foreign cities there were restrictions keeping the height below the width of the streets, and that the greatest height, 82 ft., was in Vienna.

THE BOSTON TERMINAL PLANS have been submitted to the mayor for approval, and are found to embody some highly interesting features. There will be two floors, one slightly above and the other slightly below the street level, reached by easy inclines instead of stairs. On the upper level will be 28 parallel tracks, leading out to two four-track main lines (one for the New York, New Haven & Hartford R. R., and one for the Boston & Albany R. R.). On the lower level is a double track loop with three platforms, this being intended for the suburban traffic (which, it is expected, will be operated by electric traction). Each of the two tracks can accommodate 20 cars. No switching will be required, the trains coming in on the two inbound tracks, passing round the loop, and going out on the two outbound tracks. The trainshed will be 700 ft. long and 650 ft. wide, having a central span of 228 ft 6 ins., and two side spans of 165 ft. 9 ins. The plans have been prepared by Mr. George B. Francis, M. Am. Soc. C. E., Resident Engineer for the Boston Terminal Co.

THE EAST RIVER TUNNEL scheme has received the approval of the Railroad Commissioners, and the New York & Brooklyn R. R. Co. has been authorized to proceed with the work of construction. The tunnel is proposed to extend from Fulton St., Brooklyn, to Ann St. and Broadway, in New York city. Messrs. Sooysmith & Son, of New York, are the consulting engineers.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and the worst that we have had to record for some time, was the derailment of a local train on the Birmingham Mineral R. R., near Birmingham, Ala., Dec. 27. The train was derailed on the Cahaba River bridge, and fell to the ground, 120 ft. below. The wreckage caught fire, and 23 persons were killed by the fall or in the burning of the wreck. It is said that train wreckers had loosened or taken up a rail. The bridge is about 800 ft. long, with a central span of 110 ft., and was built four years ago.

A LOCOMOTIVE BOILER EXPLOSION occurred Dec. 19 on the St. Louis, Iron Mountain & Southern Ry. at Gad's Hill, Mo. Two men were killed and one injured. The engine was standing on a sidetrack at the time.

A GRADE CROSSING COLLISION between an electric car and a passenger train of the Central R. R. of New Jersey, occurred Dec. 25, at East Allentown, Pa. The conductor signaled the motorman to come on, and then saw the train, but too late to warn the motorman. The train struck the front end of the car, killing the motorman and injuring five of the passengers.

THE MIAMI & ERIE CANAL broke its bank near Dayton, O., recently, and the water ran out into the Miami River. It is said that the bank had been badly weakened by rats.

THE FERRYBOAT "NEW BRUNSWICK," of the Pennsylvania R. R., was burned at her slip in Jersey City on Dec. 28. The boat was burned in 1889 and was then rebuilt as a double deck boat. It was one of the older type, having sidewheels instead of twin screws.

A COLLIERY EXPLOSION occurred Dec. 26 in the mine of Maule & Son, at Princeton, Ind., by which six men were killed and eight injured.

A FIRE IN A WORKED-OUT COAL MINE, located in the 13th Ward of Pittsburg, Pa., is causing much trouble to the authorities of that city, who have thus far failed to check it. It is now proposed to call in consultation a number of mining experts, including the State mining inspectors, and to act according to their advice.

A STRIKE OF EMPLOYEES occurred last week on the West End Street Ry., of Boston, Mass. Traffic on the suburban lines was largely stopped for a time, but cars were running again as usual by Dec. 26. The company employed many new men, and is giving them preference over the former employees who apply to be reinstated.

THE SOUTH 22D ST. BRIDGE, in Pittsburg, Pa., completed less than one year ago, is said, by the Pittsburg "Dispatch," to show two cracks in each of its piers, and some settlement of the foundations is feared. The matter is being investigated.

ENGLISH RAILWAY ACCIDENTS are reported upon by the Board of Trade for the 6 months ending June 30, 1896. These accidents to trains, rolling stock, permanent way, etc., caused the death of 2 passengers and 1 employee and 54 passengers, 49 employees and 5 other persons were injured. In the 6 months there were 9 collisions between passenger trains or parts of them; 15 collisions between passenger trains, and goods trains or light engines, and 13 collisions between goods trains, or parts of such trains. Trains running into stations at too high a speed, and into buffers or vehicles at rest, injured 20 passengers and 3 employees. There were 33 cases of passenger trains leaving the rails, and 8 similar cases for goods trains. In addition to the above, there were reported 259 failures of tires, 136 failures of rails, and 79 failures of axles in the 6 months. Of the axles failing, 50 were locomotive axles, and of these 31 were crank, or driving axles, and 18 trailing axles. The failing rails were all steel, except 4, and of these 36 were double-headed (of which 24 had been turned), 77 were single-headed, and 23 were Vignoles rails. The average mileage of the 13 iron crank axles that failed was 269,-511 miles; that of 18 failing steel crank axles was 267,550 miles.

SOME BADLY SCAMPED SEWER WORK at Manchester, Eng., is described in the London "Surveyor" for Nov. 6. Extensive sewer building has been under way for some time past under the direction of the Rivers Committee. A recent report by the city surveyor describes the character of some of the work done. The "Surveyor" says that "miles of sewers have been formed of half, or even less than half, the correct thickness," and presents illustrations showing vacant spaces about the sewer lining nearly as large as the sewer itself.

A DEVICE FOR TESTING THE TIGHTNESS of sewerage plumbing work of houses and other buildings is now being made by the Rossman & Bracker Co., plumbing contractors, 132 East 42d st., New York city. While we have not seen the machine in operation, the descriptive matter sent out by the makers indicates that it is a handy and serviceable apparatus for use where either the smoke or peppermint test of completed plumbing is ordinarily employed. The essential part of the device is a series of trays for developing a dark-colored vapor, with or without a pungent odor, and a 13-in. fan blower, driven by a hand crank, for forcing the vapor into the pipes to be tested. The vapor, when odorless, is formed by passing air over muriatic acid and then over ammonia. When a pungent odor is desired a third pan, filled with ether, is used. The trays and fan, with spaces for tools, are placed in a box about 28 in. sq. and 18 in. high, with the crank and wheel on top, and the whole mounted on a tricycle for convenience and rapid transportation.

IMPROVEMENTS TO THE GARBAGE DISPOSAL plant of the St. Louis (Mo.) Sanitary Co. must be made within six months, in accordance with a recent court order. The order is the result of a suit brought by citizens to compel the closing down of the works on the ground that the odors arising from the plant constitute a nuisance.

INVESTIGATION OF MUNICIPAL OWNERSHIP OF gas works in Brooklyn was voted down, 16 to 8, by the aldermen on the day following the adoption of a resolution ordering such an investigation by the aldermen of New York city.

THE 4-CT. STREET RAILWAY FARE ORDINANCE in Chicago, recently passed, has been vetoed by the Mayor, and the veto has been sustained by the council. The Mayor urges that better service is needed more than lower fares, and that it would be delayed by the proposed reduction. He also advocates the exacting of a percentage on the gross receipts of street railway companies.

THE DISADVANTAGES OF DRAWBRIDGES near railway terminals are commented upon by some of the Boston papers in connection with the new Boston Terminal Station, in consequence of a recent disabling of the low level bridge carrying the present lines over the Fort Point channel, which channel will be crossed by the line to the new terminal. It is suggested that the railway should be elevated so as to allow mastless vessels and barges to pass under it, or else that the channel should be filled in.

THE ALABAMA IRON EXPORT TRADE is rapidly developing, says a Birmingham, Ala., news item. This opinion is based upon the fact that the Tennessee Coal, Iron & Railway Co., the largest iron producer in the South, in November last sold more iron to foreign consumers than to the home trade. The exact figures are not given, however, and without them the statement means little.

A NEW PIG IRON TONNAGE RECORD has been made by the Carnegie Steel Co.'s new furnace, No. 1, located at Duquesne, Pa. In 30 days it produced 17,195 gross tons, an average of 574 tons per day. Two of the Duquesne furnaces are now in operation, and two others are in an advanced stage of construction.

MOVABLE DAMS ON THE GREAT KANAWHA RIVER, WEST VIRGINIA.

The construction, operation and general appearance of the movable dams, now being built by government engineers on the western rivers, will be novel and interesting to many engineers. As a rule the greater part of the trestles and wickets forming these dams are placed by divers after the coffer dams are removed, and the photographs here reproduced are the first we have ever seen that show clearly the various parts of the dams connected and in position. We are indebted to the courtesy of Mr. Addison M. Scott, U. S. Resident Engineer, for the use of these photographs and for the general elevation, and the notes which we have made use of in describing this work.

Dam No. 11, where these photographs were taken, is within 1¾ miles of the mouth of the river and is the lowest lock and dam in the Great Kanawha system. While all the other dams are founded upon rock, lying from 5 to 13 ft. below low water, this dam rests upon a compact indurated clay, or hard pan, lying from 19 to 24 ft. below low water mark. The character and depth of the river bottom at this point called for a material modification in the foundation plans; and the methods plainly shown in Fig. 1 were adopted.

It may be stated here that the improvements on the Great Kanawha River when completed will include ten locks and dams, covering 90½ miles of the river. The two upper dams in this system are fixed, with a maximum lift of 12 ft.; but all below that are movable with lifts varying from 6½ to 10 ft., and giving a navigation pass generally 248 ft. wide, and a weir from 210 to 372 ft. wide. Dam No. 11, however, provides a pass 304 ft. wide, and Dam No. 5 has a pass 250 ft. wide. With the fixed and movable dams are locks, 50 ft. wide at Dam No. 6, and 55 ft. wide below that, and 342 ft. long between quoins for all locks below Dam No. 6, inclusive. Locks and dams Nos. 4 and 5 were completed and put into operation in July, 1880, and were the first movable dams for slackwater navigation in America. Three other movable and the two fixed dams have also been completed and three others are now under construction. This improvement of the Great Kanawha River is mainly designed to facilitate the transport of coal carried down the river in barges usually 130 ft. long by 25 ft. wide, and drawing 6½ ft. The minimum low water depth on mitersills is 7 ft.

Returning to the description of Dam No. 11, we find a navigation pass 304 ft. wide closed by 76 Chanoine wickets operated by a service bridge. These wickets are 14 ft. 1 in. long and 3 ft. 8 ins. wide each, with their tops 13 ft. vertically above the sill. The bridge trestles are 8 ft. apart between centers, and they are 16 ft. 10 ins. high; thus placing the foot-bridge 2 ft. 6 ins. above the level of the upper pool, with the wickets closed. With the exception of the La Mulatière dam, at Lyons, France, which has wickets 14 ft. 3½ ins. long, these are the largest wickets ever built.

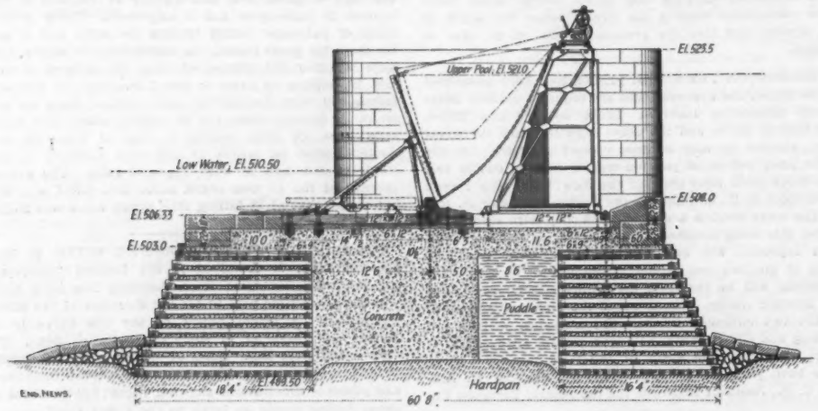


FIG. 1.—GENERAL SECTION OF NAVIGATION PASS, WITH CENTER PIER IN ELEVATION; GREAT KANAWHA RIVER IMPROVEMENT.

The lowering of the wickets is performed by means of the winch and chains shown in Fig. 1. Each wicket is first put on the swing, as shown by the dotted lines, and then pulled up-stream far enough to free the end of the prop from its seat in the Pasqueau hurter, and it is then lowered by the winch and butt chain. This method is shown in Fig. 1; but the general Kanawha River practice is to place a clutch and double rope over the top of the wicket, as is shown, and to pull the standing wicket by the top until the prop is free, and then to disengage the clutch and let the wicket fall. The advantage of the second method is a great saving in time, as the operation of lowering can be done in about one-fourth of the time, and the two or three hours thus saved may be of great importance when a quick rise in the river occurs. No injury is done to the wickets by this method, as the water below soon checks the rapidity of the fall, and the wicket settles down on the cushions without any noticeable shock. As is more plainly shown in the photographs, the bottom of each wicket-trestle is hinged to the dam and the top carries two journals, upon which the wicket is articulated, and a third journal which carries the prop for supporting the wicket. When the wickets are down the wicket-trestle and the props lie in the same line on the floor and the wickets themselves lie flat above them. When the dam is to be raised, a strong pull on the up-stream end of the wicket raises the trestle and the wicket and the prop follow until the foot of the latter drops into the notch in the hurter provided for it. The up-stream end of the wicket is then depressed until it strikes the wooden sill shown, and the wicket stands in a nearly vertical position and does duty as part of the dam. The wickets, when raised, do not touch each other by one or two inches, and this space is usually closed by a scantling dropped into the opening on its diagonal.

The peculiarity of the Pasqueau hurter here employed is that the prop pursues one path while the trestle is rising, and another while it is being lowered. In the rising path is the notch, or step which engages the prop, when it has reached the proper height, and holds the wicket firmly. When the trestle is pulled slightly up-stream, however, the foot of the prop follows and reaches a point where the track terminates; it then slides sideways into the second and unobstructed track and moving down it, allows the trestle and wicket to fall freely. As will be seen in the photographs, the trestles carrying the operating foot-bridge

FIG. 2.—NAVIGATION PASS, DAM NO. 11; LOOKING TOWARDS LOCK, FOOT-BRIDGE TRESTLES AND WICKET-TRESTLES RAISED AND PART OF THE WICKETS IN PLACE.

FIG. 3.—NAVIGATION PASS, DAM NO. 11, LOOKING TOWARDS CENTER PIER; SHOWING UNDER SIDE OF WICKETS AND WICKET-TRESTLES, AND THE PASQUEAU HURTERS.

are also hinged on the line of the dam, and when the wickets are all down and the navigation pass is opened these trestles can also be let fall so as to fold one over the other and present no obstruction. For a more detailed description of the operation of these dams we would refer our readers to a paper read by Mr. Scott before the American Society of Civil Engineers and published in the Transactions, vol. xxxi., p. 539.

The construction of the lock and dam here described was commenced in 1893. At the present time the lock masonry is nearly completed and the navigation pass is practically so, and since the photographs were taken the cofferdams have been removed. Assuming a fairly good season for river work the locks and dams Nos. 9, 10 and 11 will be completed next year. From the beginning of work upon this slackwater improvement, in 1874, up to 1894, Gen. William P. Craighill, the present Chief of Engineers, U. S. A., was in charge of this work. Since 1894 Col. Peter C. Hains, Corps of Engineers, U. S. A., has had charge. The construction of dams Nos. 9 and 10, with their locks on this same stream, were described and illustrated in our issue of Aug. 13, 1896.

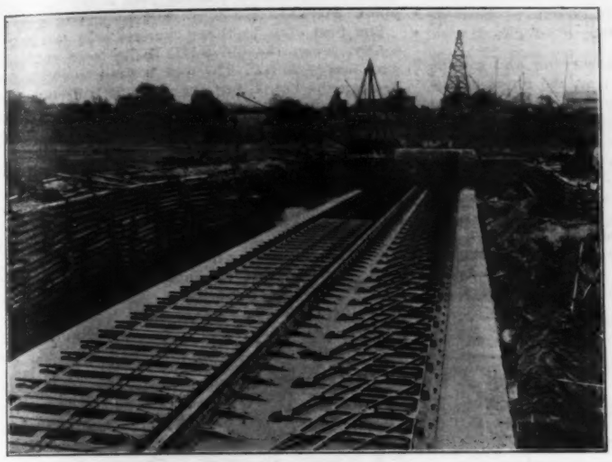


FIG. 4.—NAVIGATION PASS, DAM NO. 11, LOOKING TOWARDS CENTER PIER; WICKET AND OPERATING BRIDGE TRESTLES LOWERED. ONLY PART OF THE WICKETS IN PLACE.

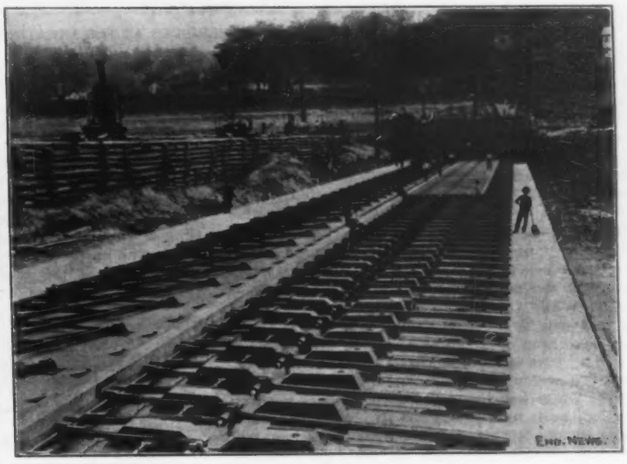


FIG. 5.—NAVIGATION PASS, DAM NO. 11, LOOKING TOWARDS LOCK; WICKET-TRESTLES AND PROPS DOWN; SHOWING THE CONSTRUCTION OF THE WICKET-TRESTLES AND THE PROPS AND HURTERS.

COMPARATIVE COST OF ENGLISH AND AMERICAN BOILERS.

We have received some data from Mr. Geo. I. Rockwood, M. Am. Soc. M. E., of Worcester, Mass., who has recently returned from a three months' visit to Europe, concerning the relative prices of steam boilers in England and in the United States, which are of interest as illustrating the wide difference in the practice of the two countries. Comparing the ordinary horizontal fire-tube externally fired boiler, which is most common in this country but is almost unknown in England, with the Lancashire internally fired boiler, which is the old-time English favorite but is not used at all in this country, Mr. Rockwood says:

In Worcester or Boston the price, for instance, of a 72-in. × 20-ft. horizontal return tubular fire-tube boiler, f. o. b. cars, with all fixtures, is $1,000. This boiler has about 2,000 sq. ft. of heating surface, giving, at 12 sq. ft. allowed for one boiler horse power, a total of 166 HP. $1,000 divided by 166 gives $6.25 as the cost per HP. The price of a 66-in. × 18-ft. boiler, f. o. b. cars, with all fixtures, is $800. This boiler has about 1,550 sq. ft. heating surface, or 130 HP. $800 divided by 130 gives again $6.25 as the cost per HP.

These boilers are made to first-class specifications having ½-in. shells of best fire-box steel, triple-riveted butt-strap joints, with rivet holes drilled. They are guaranteed "drop-dry" at 225 lbs. water pressure, and to withstand a working pressure of 150 lbs. steam all their lives.

Now the price quoted me for the 8 ft. diam. × 30 ft. length Lancashire boiler was 20% and 2½% off from £585 [(585 − 117) − 11.7] = £456.3. Calling £1 $4.90 in round numbers, gives $2,235, f. o. b. cars, as the cost of the Lancashire boiler in American money. The total heating surface is 1,080 sq. ft., which makes the boiler cost $2.07 per sq. ft. as compared with 52 cts. a sq. ft. for each of the two American boilers; thus the Lancashire boiler is about four times as expensive per sq. ft. of heating surface. But, on the other hand, the heating surface of the English boiler is more effective than it is in the return tubular boiler; not only because the Lancashire fire-box is inside instead of outside the shell, but also because of the higher temperature at which the flue gases escape.

The claim is made that the English boiler will evaporate economically 6,500 lbs. of water from and at 212° per hour, the maximum evaporation being 8,000 lbs. Taking 8,000 lbs. = 230 boiler HP. gives 2,235 ÷ 230 = $9.75 as the cost per HP. If we take the maximum power of the 66-in. × 18-ft. boiler as 175 HP. (obtained with a combustion of 18 lbs. of coal per sq. ft. of grate per hour) then the comparative cost of the American boiler is less than half that of the English type. Whether the Lancashire boiler could be made in the United States at a price less than it can be purchased for now in England is an open question, as we have no data or experience from which to form an opinion; it seems to me not impossible, as the prices of all steam goods in this country are so much depressed by the severe domestic competition which has developed at a rapid rate within a comparatively recent period.

The only internally-fired boiler which is used much in the factories of the United States—the Manning type—is still much cheaper than the Lancashire boiler, costing but $7.70 per HP. when built for the highest pressures, and requiring no brick work. The item of brick work should also be considered in estimating the comparative cost of the return tubular and Lancashire boilers. On account of the great weight per HP. of the Lancashire when filled with water, and also on account of its great length, 30 ft., it is necessary to provide much deeper and better foundations for it than we provide for the American type, and in addition, separate brick return-flues must be used for the Lancashire, as it is not economical to operate the boiler without the use of an economizer. The reason for this appears when one takes into account the relative cost of the heating surface in the Lancashire boiler and in the Green economizer. The cost of the economizer, all erected ready to be operated except for the brick setting, is 30 shillings per tube, $7.35. This makes the cost per square foot of heating surface 73 cts., as the tubes are 4 ins. diam. × 10 ft. long, and thus have about 10 sq. ft. of surface per tube. As the heating surface in the boiler costs 8.4 shillings, or $2.07 per foot, whereas that in the economizer costs 3 shillings or 73 cts. per foot, it is plainly to the advantage of the Englishman to buy as much economizer and as little boiler as he can use. The dividing line comes in at about the middle of the whole amount of surface needed; that is, the economizer is given the same number of square feet of heating surface as is provided in the boiler.

In this country the economizer costs something more than double the cost of the boiler per square foot of heating surface, and is, therefore, of more specialized utility than must be the case in England.

It should be said that brick work is done far cheaper in England than in the United States, a "one hundred yards" chimney costing less than half what we should pay. The same ratio of cost obtains, of course, in brick boiler settings.

To further exemplify Mr. Rockwood's comparison we may compare the combination of the Lancashire boiler and its economizer, which will evaporate economically 6,500 lbs. of water per hour from and at 212°, with an American tubular boiler designed to do the same work without an economizer; one horse power being taken at 34½ lbs. evaporation per hour from and at 212°, and American practice giving 12 sq. ft. of heating surface per HP. This gives an evaporation of 2.875 lbs. per sq. ft. of heating surface per hour. The American boiler would, therefore, have 6,500 ÷ 2.875 = 2,295 sq. ft. heating surface, which would ordinarily be furnished in two boilers. At the price given by Mr. Rockwood, 52 cts. per sq. ft., this would cost $2,295 × $0.52 = $1,193. The English boiler for the same service would have 1,080 sq. ft., costing $2,235. But the English boiler, in order to operate economically, needs to be provided with an economizer. The heating surface of the required economizer is equal to that of the boiler, or 1,080 sq. ft., at 3 shillings or 73 cts. a foot, equals $788, which, added to $2,235, gives $3,023 as the cost of the boiler and economizer without brickwork, or nearly three times the cost of the American boilers.

As to the relative economy of fuel of the two systems, there is probably little difference. The American boiler, when run at an economical rate of less than three lbs. evaporation per sq. ft. of heating surface, will discharge its gases at about 400° F. The Lancashire boiler will discharge them at 800° or 900°, and the economizer will, when it is kept clean, reduce them to 300°, an advantage of 100° in favor of the English system. The English system undoubtedly has the advantage on the points of safety and durability, and it is a characteristic of the Englishman that he is willing to pay a good round price for what he considers the best article, while the American is apt to consider first cost as the prime consideration.

HOLLOW FORGED STEEL SHAFTS, made by the Bethlehem Iron Co., South Bethlehem, Pa., have been introduced on stern wheel steamboats on the Ohio and Mississippi Rivers. The company recently closed a contract with the Pittsburg & Cincinnati Packet Line, of Cincinnati, O., for a hollow forged nickel steel oil tempered shaft, 38 ft. 9 ins. long, 14 ins. outside diameter, with a 7-in. hole running through it. Such a shaft is 3,500 lbs. lighter and 3½ times stronger than the solid wrought iron shaft which ordinarily would be placed in such a vessel. This shaft is for a new vessel which the line is having built by the Cincinnati Marine Railway Co., of Cincinnati, O. A similar shaft is to be put into the new steamer which the Mississippi Valley Packet Line, of New Orleans, La., will shortly build.

THE WOODILINE PRESERVATIVE FOR TIES AND TIMBER.

In most of the processes of treating railway ties and timber with preservative compounds, considerable time and care are expended in first extracting the sap and then forcing in the preservative compound under heavy pressure, such processes requiring the establishment of extensive and costly plants. A process which is now being brought to the attention of railway officers, and which has already been used to a large extent by a prominent eastern railway, consists in immersing the timber in a hot bath of a liquid called woodiline, which readily penetrates even such hard wood as white oak. The actual composition of the liquid is not made public, but we are informed that it is a mixture of certain powerful antiseptics with wood-creosote, and other ingredients. The liquid is said to solidify and harden after entering the timber, so that the timber is not only made materially tougher in its outer fibers, but the wood-creosote is not liable to be washed out under the action of moisture, or to be evaporated. While the best method for impregnating the timber is by dipping it into the liquid, good results have been obtained by applying the preservative hot, with a brush, three coats being used. Some 800 gallons were used in this way in treating the white oak ties and guard timbers used on a bridge built by the Cincinnati, New Orleans & Texas Pacific Ry. over the Cumberland River last summer. Which ever way is used, the cost per tie varies from 15 to 19 cts., including material and labor.

It is desirable that the timber should be dry before being treated, and all the experiments made indicate that one gallon of the liquid will adequately treat 40 to 50 sq. ft. of surface. If desired, more may be used, but it is not considered necessary. The liquid does not form a surface coating upon the wood, but penetrates it more or less deeply, depending on the duration of treatment, kind of timber, etc. The pores, however, are not sealed up, and if there is moisture at the heart of the wood, it may escape, so that dry rot is avoided.

Regarding the penetration of the material into such hard woods as oak by simple immersion, it is of interest to note that several prominent railways have used woodiline to a considerable extent in the treatment of oak, one road in particular having used somewhat over 12,000 gallons during the first half of the present year, largely on oak ties and bridge timbers.

The treatment of timber in this way requires only very simple and inexpensive apparatus, such as may readily be duplicated at as many points as desired. The first cost of a treating plant, and the cost of transporting timber to and from the plant are considerations to be taken into account in estimating the cost of treating timber, and in this process the liquid is supplied ready for use and can be readily and cheaply applied at any convenient point. The treatment, we are informed, does not impair the strength of the wood or render it brittle.

The first important use of woodiline in railway work, was on the Amboy Division of the Pennsylvania R. R., where some treated ties of red and black oak were laid in 1883. These ties are just outside of the station at Camden, N. J., in a rather unfavorable location. The traffic over them is heavy, but they are still sound, and in place in the track, after a service of about 13 years, and while there has been some slight cutting under the rails, this has not been sufficient to warrant the removal of the ties. This fact is regarded by the makers as a striking proof of the hardening and toughening effect of the treatment on the fibres of the wood. It is interesting, by way of comparison, to note that two, and in some cases three, sets of untreated white oak ties have been removed from positions immediately adjoining these treated ties.

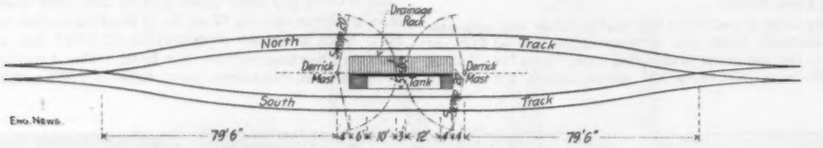


FIG. 2.—PLAN OF TRACKS AND DERRICKS AT THE TREATING TANK.

To obtain further evidence as to the probable value of woodiline, other tests, of a similar nature, but including white oak ties, were made from time to time, at various points along the line of the road. The uniformly good results obtained caused the officials of the road to look with increasing favor on the process, especially for such work as bridge ties, trestle timbers, guard timbers, etc. In 1895 plans were made for a treating tank to accommodate ties and timbers up to 30 ft. in length, and this was built during the latter part of that year. This tank, shown in Fig. 1, is 35 ft. long, 5 ft. wide and 6 ft. deep, built of ⅜-in. iron. Its edges are supported by heavy timbers, and a coil of 1½-in. steam pipe, laid inside, around the bottom, serves to heat the liquid to about 150 deg. F. A small, upright boiler, placed in the boiler house near by, supplies steam. Plank platforms surround the tank, and it is provided with a removable cover to keep out rain. The cost, with all details, exclusive of the boiler, was about $390.

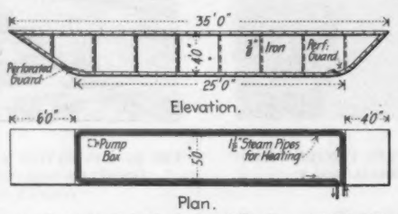


Fig. 1.—Tank for Treating Ties and Timber with Woodiline; Pennsylvania R. R.

During the spring and summer following the completion of this tank, about 12,000 gallons of the preservative were used, many thousand ties and timbers being treated. The ties were thrown in at one end of the tank, until about 70 had been immersed, those first thrown in being gradually pushed to the opposite end of the tank, whence they were removed by pike poles. The average time of immersion for each tie is about 12 minutes, during which time about ½ gallon of the liquid per tie is absorbed. The experiments made indicate that this amount is sufficient for a tie of standard size. It is, of course, evident, however, that by increasing the time of immersion, a greater amount of the liquid may be absorbed. An immersion of three hours, with a close-grained, black oak tie, showed about 1½ gallons absorption. With the bath at a higher temperature, these figures could be increased.

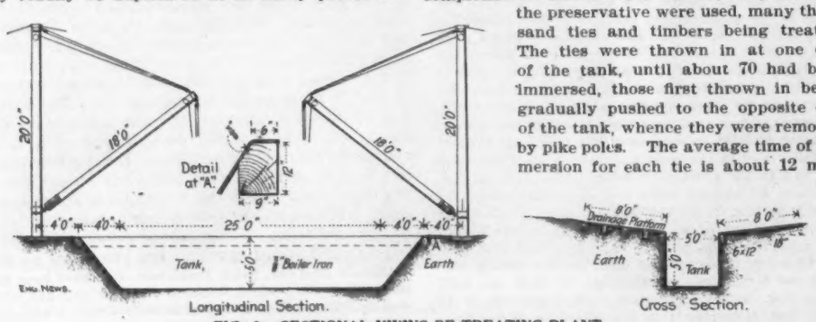


FIG. 3.—SECTIONAL VIEWS OF TREATING PLANT.

Some objections were found to the treating tank in its original form, and plans were made for an improved plant. It was thought that, with a different arrangement of tracks, and with the addition of derricks for the rapid and economical handling of heavy timbers, the capacity of the plant would not only be increased, but the cost of handling the timber would be reduced. It was also thought best to build an inclined platform alongside the tank, upon which the timber, after treatment, might be allowed to lie for a short time, in order that the superfluous liquid clinging to it might drain back into the tank. This drainage platform, of 2-in. pine planks, with oak battens, 1 × 3 ins., over the joints, to keep the timbers clear of the platform and allow the liquid to drain under them, is shown in the plan of the improved plant, Fig. 2.

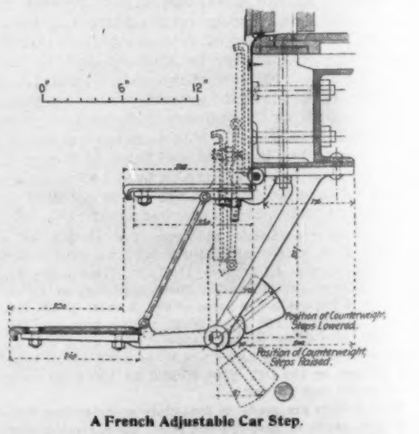
The first step in these changes was taken recently, when the old 8 HP. boiler was replaced with one of 20 HP. The first boiler was ample for heating the liquid, but the new one is designed to serve the double purpose of heating the liquid and driving the hoisting engine of the derricks. With a plant such as that just described, the untreated ties delivered at the cars on one track, will be made up into bundles of 10 to 15 ties, secured by chains; the bundles will then be placed in the tank, and after a proper interval will be lifted on to the draining platform and from there loaded onto the cars on the other track. With sawed ties, sticks of wood may be placed between them, or a cast-iron separating frame may be used to keep them apart. Such a tank will hold three bundles of ties at one time, and its capacity should be from 1,200 to 1,500 ties per day. As formerly used, the capacity of the tank was, at a maximum, 600 ties per day. The improved arrangement of tracks and derricks is shown in Fig 2. Fig. 3 shows a section of a tank similar in many respects to that of the Pennsylvania R.R. It is, however, set deeper in the ground, and is a little shorter, and not quite so deep.

A novel form of tank has been suggested, consisting of an ordinary coal or gondola car, lined with sheet iron, thus forming a tank of size to accommodate large timbers. Steam for heating the liquid could be taken from the locomotive drawing the car, and a pole derrick set up at stopping points for handling the timber. Or, if desired, a crane, engine and boiler could be carried on a flat car coupled behind the tank car.

The process is controlled by the American Wood Preserving Co., of Philadelphia, Pa. Mr. Fred A. Kummer, Room 502, 72 Trinity Place, New York city, is the general representative of the company.

A LET-DOWN STEP FOR A FRENCH RAILWAY CAR.

On the occasion of the late visit of the Tsar of Russia to France the Compagnie Internationale des Wagons-Lit built a special train for the use of the imperial party, which train was made up of sleeping and dining cars, and a car especially arranged for receptions, etc., or seven cars in all. The majority of these cars had end-entrances, with a passage way down one side in the case of



A French Adjustable Car Step.

doors with steps were necessary, and to make these latter easy of ascent and yet capable of being folded up out of the way of station platforms, etc., a special step was devised.

This step is here illustrated from a cut in "Le Genie Civil," and practically describes itself. It is a counter-poised, double, folding step, requiring a force of only 5 kilograms, or 11 lbs., to operate it. When the train is in motion the steps take the position indicated by the dotted lines.

A HYDRAULIC RAM PLANT FOR A PUBLIC WATER SUPPLY.

The hydraulic ram has been used in a small way ever since its invention by Joseph Michael de Montgolfier, in 1796, to whom credit is given for having first perfected the automatic machine. John Whitehurst, of Derby, England, is said, however, to have understood the principle as early as 1775, but his machine required an attendant who opened and closed the waste valve by hand.

Hydraulic rams are in quite common use, but they are practically all of small size, designed to raise but small quantities of water and that to small heights.

The Power Specialty Co., 126 Liberty St., New York city, however, is manufacturing an improved ram, which is of sufficient size and capacity to deserve the name of engine. A section of the so-called double acting or double supply type, to be described later, is shown in Fig. 1. Considering it first without regard to the double supply feature, suppose the opening at H to be closed. The valve at B being open, the water from the source of supply at more or less elevation above the machine flows down the drive pipe A, and escapes through the opening at B until the pressure due to the increasing velocity of the water is sufficient to close the valve B. At the moment when the flow through this valve ceases, the inertia of the moving column of water produces the so-called ramming stroke which opens the valve at C and compresses the air in the air chamber D until the pressure of the air plus the pressure due to the head of water in the main is sufficient to overcome the inertia of the moving column of water in the drive pipe. This motion may be likened to the oscillation of water in an U-tube. At this instant the column of water in the drive-pipe has come to rest, and the air pressure being greater than the static head alone the direction of motion of the moving column is reversed and the valve C closes. The water in the drive-pipe is then moving backward and with the closing of C a tendency to a vacuum is produced at the base of the drive-pipe; this negative pressure causes the valve B to again open, completing the cycle of operations. At the moment of negative pressure the little snifting valve E admits a small quantity of air, and at the following stroke this passes into the air chamber which would otherwise gradually fill with water, the air being gradually taken up by the water.

In many machines the mistake is made of making the waste valve B sufficiently heavy to overcome the static head of water in the drive-pipe. In fact most writers on this subject, including the "Encyclopedia Brittanica," state that the weight of the waste valve B must be greater than the pressure of the statical head of water on its under side, so that it may open when the column of water comes to rest. In the machine which we are describing this would be practically impossible on account of the large area of the opening at B.

In this machine the valve B is made as light as is consistent with the necessary strength; the negative pressure at the end of the stroke is relied upon to open the valve. With the largest size of these machines this valve is 18 ins. in diameter, and with a head of 8 ft., which is a common head for use with hydraulic rams the static pressure on the under side of this valve is 883 lbs.; it can be seen that the great shock of a valve of this weight would rapidly destroy the valve and its seat.

The waste mechanism of the Rife engine consists of a large port with flat ample opening and a large rubber valve with a balance counterweight and spring seating, removing almost entirely the jar of closing. The valve C in the air chamber consists of a rubber disk with gridiron ports and convex seat, fastened at the center and lifting at the circumference, as shown by Fig. 4. The effort is to transfer the power from the shock of the driving water through to the air cushion with the smallest possible amount of friction and jar.

After the closing of the valve C the pressure of the air in the air chamber forces the water in the air chamber out into the delivery pipes. With the Rife engine the manufacturers claim to elevate water 30 ft. for every foot of fall in the driving head; the machine is built in capacities as high as 150,000 gallons per day and the efficiency of 82% is claimed.

The engine illustrated in Fig. 2 weighs 2,800 lbs.; the capacity of the air chamber is 20⅝ cu. ft.; diameter of drive pipe, 8 ins.; diameter of waste valve, 18 ins.; weight of waste valve, 50 lbs.; diameter of delivery pipe, 4 ins.; height to top of air chamber, 7½ ft.

To the reader who has carefully followed the above description, it will be clear that the most important detail in which the Rife engine differs from the ordinary hydraulic ram is the waste valve. It will be seen by the drawing that the counterweight on the projecting arm of this valve permits the adjustment of this valve to suit varying heads and lengths of drive pipe. By adjusting the counterweight so that the valve is nearly balanced the valve comes to its seat very quickly after the flow past it begins. The result is that the ram makes a great number of short, quick strokes, which are much easier on the mechanism than slower and heavier strokes. Of course the stroke must be sufficiently powerful to act efficiently in overcoming the head in the delivery pipe. The adjustable weight permits this to be effected with the greatest nicety.

The question of efficiency of hydraulic rams has been much discussed, and such authorities as Rankine and D'Aubisson differ considerably in their calculations. The Power Specialty Co. uses Rankine's formula in calculating efficiency, which is

$$E = \frac{q\,h}{(Q-q)\,H},$$

where Q is the quantity of water flowing per second in the drive pipe; q, the quantity flowing per second to the stand-pipe through the discharge pipe; H, the height from the escape valve to the level of the reservoir which feeds the drive pipe; and h the difference in level of the water supply reservoir and the water in the stand-pipe. D'Aubisson states the formula for efficiency as

$$E = \frac{q\,(H+h)}{Q\,H}.$$

D'Aubisson's is the correct one, considering the mechanism as a machine receiving energy at one end and delivering it at the other, while if the machine is considered as elevating water only from the one reservoir to the other, Rankine's formula is the correct one to use.

When a pipe is attached at H (Fig. 1), the engine is termed double acting; spring water or that which is purer than the water used to drive the engine may then be supplied through I, and by a proper adjustment of the relative flow of the impure driving water and that of the pure supply the engine may be made to deliver only the pure water into the mains. This method is used where the supply of pure water is limited.

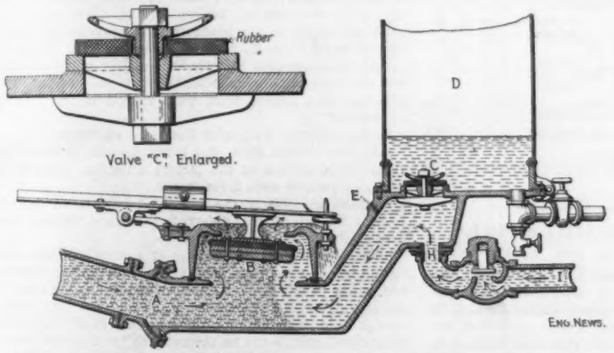


FIG. 1.—SECTION OF RIFE HYDRAULIC RAM FOR PUMPING PURE WATER, USING IMPURE WATER FOR POWER.

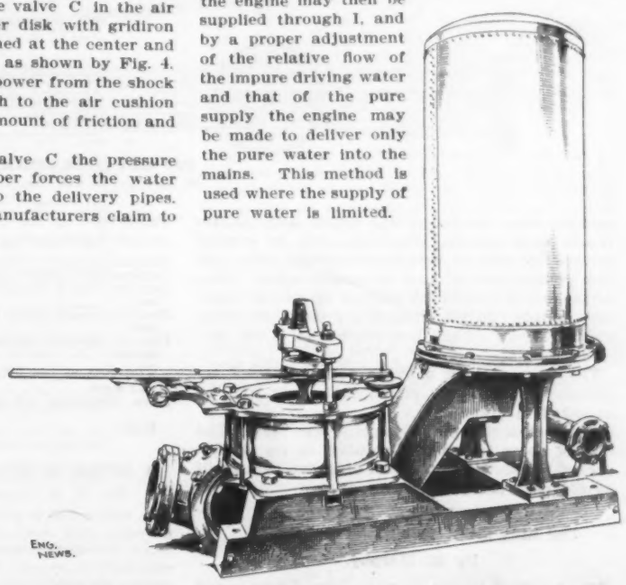


FIG. 2.—PERSPECTIVE VIEW OF THE RIFE HYDRAULIC ENGINE. Made by The Power Specialty Co., 126 Liberty St., New York City.

A battery of five Rife engines is now being installed in connection with a water-works plant at West Reading, Pa. The driving water is supplied from Wyomissing Lake, which delivers 810 gallons per minute. The battery of engines which will consist of three large and two small rams is located nearly 200 ft. from the lake; a fall of 8 ft. is obtained by a 4 ft. dam across the outlet of the lake and by sinking the engines in a pit; this pit is drained into the stream at a point further down. Each of the three large engines has a separate wrought iron drive pipe 194 ft. long and 8 ins. diameter.

The water to be delivered to the city stand-pipe comes from a spring 1,000 ft. away and at an elevation of 8 ft. above the level of the lake. The spring water is carried by a 6-in. pipe to a small stand-pipe, situated on the dam. Under the conditions of the contract this spring water had to be delivered to the city stand-pipe without mixing with the water from the lake. With a fall of 8 ft. from the surface of the lake to the engines, the spring water must be delivered to the base of the large No. 80 engines under a head of only 2½ ft. in order to avoid wasting the spring water, and at the same time prevent lake water passing into the city mains. From the spring level to the base of the No. 80 engines there is a fall of 16 ft. To reduce this head from 16 to 2½ ft., two so-called single acting engines, No. 40, are interposed, which are driven by spring water alone. The spring flows about 120 gallons per

minute. Half of this is delivered to each No. 40 engine under a head of 13 ft., and they pump directly into the main. The waste spring water from the No. 40 engines is delivered into a small reservoir in the corner of the pit where the three large engines are situated. This reservoir overflows at a point which maintains a constant head of 2½ ft. on the three No. 80 engines. The main which leads to the stand-pipe is 6 ins. diameter and 1½ miles long. The elevation of the water in the city stand-pipe above the engine pit is 175 ft. The two No. 40 engines pump into the main six gallons per minute, or 8,640 gallons per day, and discharge by waste 114 gallons per minute into the reservoir, which supplies the three large engines. The three No. 80 engines receive 810 gallons per minute of lake water and 114 gallons per minute of spring water. They force into the main 25 gallons of spring water per minute, 36,000 gallons per day; the combined delivery of the five engines is 44,640 gallons.

The figures given above are the contract requirements, and it is stated that they will be exceeded in practice.

The cost of this pumping plant was $3,000. The cost of operation will be nothing, as no attendance is required, and the cost of maintenance will be $32 per year for new valves.

THE MIRA RIVER BRIDGE, NOVA SCOTIA.

By M. Murphy.*

The highway bridge over the Mira River is not remarkable for its size, nor for the difficulties attending its erection, but for the cheapness with which it was constructed. The Mira River is navigable for small craft for a distance of about 20 miles from its mouth. Its width is irregular, narrowing between cliffs of sandstone for some miles up, and extending into lakes still further up. Heavy ice forms in the still waters of these basins in the winter season, and is carried downwards with the stream in the spring, with sufficient velocity to destroy an ordinary structure, where the channel is contracted and the current is strong. For this reason, a bridge spanning the whole stream was considered the most advisable to adopt. The span is 140 ft. between piers, so that a vessel can beat through against the wind and tide. The highway traffic is of a light, rural character, hence the lightness of the design.

The construction of the circular pivot piers for the bridge may be worthy of remark. They are founded on flat stones, placed as regularly as possible without the aid of dams in the stream, up to extreme low tide. Upon this foundation is spread a 2 ft. bed of Portland cement concrete, covering the whole base of the pier. From thence, up to the top the pier is built hollow, as shown by the plan. A passage communicates with each open space, so as to allow a man to examine the machinery of the swing span and paint it when necessary. The walls are of Portland cement rubble concrete, faced with Portland cement fine concrete. The plan shows the temporary wooden casing, within which the walls were built.

The bridge is located near the mouth of the river, where it empties through a shingle beach into Mira Bay.

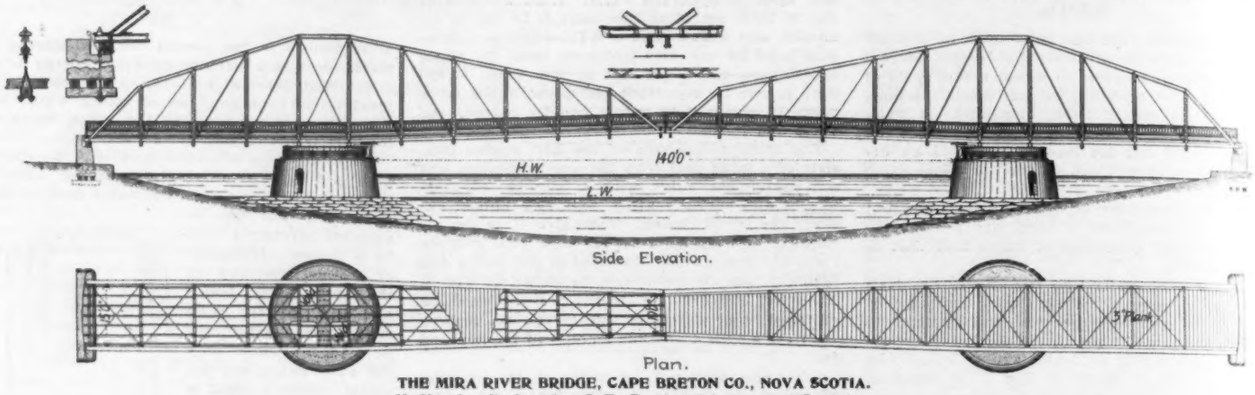
The bridge crosses the stream by two cantilever draw spans, on pivot piers of concrete on each side of the stream, the short lever arm of each truss being anchored to the abutments, when the bridge is closed across the river. The roadway is 15 ft. at pivot piers and 10 ft. in the clear at the center, so as to prevent two teams from passing each other on the extreme points of the lever arms at one time.

The bridge is proportioned to carry a rolling load of 80 lbs. per sq. ft. of roadway, plus the static load of the bridge. The specifications included the following requirements:

Ultimate strength of iron	50,000 lbs.	per sq. in.
Compressive strength of iron	40,000	" "
Greatest tensile strain must not exceed	10,000	" "
Shearing across grain must not exceed	7,500	" "
Pinhole intrados bearing must not exceed	12,500	" "

The cost of the bridge was as follows:

Metal work	$6,700
Piers, abutments and approaches	2,318
Total	$9,018

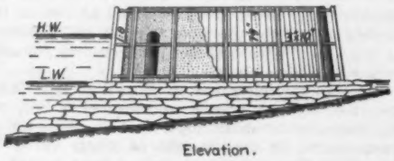


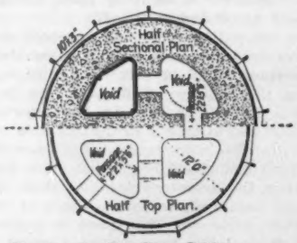
THE MIRA RIVER BRIDGE, CAPE BRETON CO., NOVA SCOTIA.
M. Murphy, M. Can. Soc. C. E., Provincial Government Engineer.

A METHOD OF DETERMINING SELLING PRICE.*

By H. M. Lane, M. Am. Soc. M. E.**

In business it is necessary that both ends meet, and desirable that they overlap. To accomplish this, receipts or value produced must exceed expenditure. It is customary to transact business for a year, and then ascertain the results from the records, at a time when it is too late to apply remedies which would affect the result of that year. It is the purpose of this paper to propose a method by which the conditions affecting the final result of a year's business may be shown in a simple manner at the end of each month or week. It is in no sense a substitute for the usual bookkeeping and inventory, but an auxiliary for the convenience of the manager relating to organization and operation.





Pier for the Mira River Bridge.

There are in these close times concerns of which it is true that 25 years ago a difference of 10% in the result of a year's business would have been a profit of 25 instead of 35%, while now a difference of 10% would probably mean a loss of 5% instead of a profit of the same amount.

It is the purpose here to show what the volume of product must be, and what value must be placed upon it unsold, or what selling price when sold, in order to make both ends meet and to overlap for a given organization and general expense.

First, an annual estimate or prospectus, Table I., for the succeeding year, is prepared, based upon experience and judgment. In this case the capital invested in the business is assumed to be $100,000, and the annual pay-roll to be $50,000, equally divided between producers and non-producers. All those whose time can be directly ascertained and charged against some specific order or article produced for sale are classed as producers, and all others as non-producers, and in case of doubt safety lies in erring on the side of classing an individual as a non-producer rather than a producer. The column, Estimated Expenditure, Table I., requires no explanation. It shows in this assumed case that for the conduct of the business for the succeeding year $156,000 must be secured. The question then arises, from what sources is this sum to be derived?

In the column, Estimated Receipts, adjoining:

(a) Fixed income $600, this being the sum derived from rental of a portion of the factory buildings, interest on bonds or returns from investments.

(b) Interest $400 is the estimated sum to be derived from notes given for deferred payments, overdue accounts, etc.

(c) It is assumed that in case of a machine shop with tools varying greatly in size, value, floor space occupied, and power required, that there should be a separation of the charge for the workman and for the tool. The hourly charge for a man at 25 cts. working on a $5,000 horizontal boring-mill should not be the same as for the same priced man working on a $300 lathe. Separating tool time from workman's time, it is estimated that the tools would yield a plant charge of $5,000.

(d) Material and merchandise are estimated at $75,000. This item is the same as in the column of estimated expenditures, to which is added, say, 20% (e), which yields $15,000.

(f) Producer's wages is the estimated amount to be derived by charging producer's actual time at his actual rate against the product. The sum of all these estimated receipts is $121,000, while the sum of the estimated expenditures is $156,000, which would show a deficit of $35,000 on the year's business. Now from what source is it possible to secure this $35,000? Clearly from a percentage added to producer's wages. In this case producer's wages are $25,000, and in order to derive there-

TABLE I.—Annual Estimate. Assume Capital $100,000. Annual Pay-Roll, Producers, $25,000; Non-Producers, $25,000.

Estimated Receipts.		Estimated Expenditures.	
a—Fixed Income	$600	Profit	$10,000
b—Interest	400	Losses	500
c—Plant charge	5,000	Renewals	2,000
d—M't'rial and mdse	75,000	Depreciation	2,000
e—20% to material & mdse	15,000	Producers' wages	25,000
f—Producers' wages	25,000	Non-producers' wges.	25,000
	$121,000	Material and mdse.	75,000
g—140% to producers' wages to balance	35,000	General expense	10,000
		Stable and hauling.	500
		Printing and stationery	300
		Freight and express.	500
		Advertising	1,000
		Postage	200
		Insurance	1,000
		Commissions	200
		Interest & discounts	800
		Charity	200
		Legal	300
		Fuel	500
		Contingent	1,000
	$156,000		$156,000

*Provincial Government Engineer of Nova Scotia.

*A paper presented at the New York meeting (Dec., 1896) of the American Society of Mechanical Engineers.
**President The Lane & Bodley Co., Cincinnati, O.

TABLE II.—FORM FOR TABULATED MONTHLY STATEMENT OF RECEIPTS AND EXPENDITURES, ESTIMATED AND ACTUAL, IN A MANUFACTURING BUSINESS.

Months Ending.		Jan. 31.	Feb. 28.	Mch. 31.	April 30.	May 31.	June 30.	July 31.	Aug. 31.	Sept. 30.	Oct. 31.	Nov. 30.	Dec. 31.
Expenditures read down.													
Profit	Estimated	666.66	1,666.67	2,500.00	3,333.34	4,166.67	5,000.00	5,833.33	6,666.67	7,500.00	8,333.33	9,166.67	10,000.00
	Actual	666.66	1,666.67	2,500.00	3,333.34	4,166.67	5,000.00						
Losses	Estimated	41.66	83.33	125.00	166.66	208.33	250.00	291.66	333.33	375.00	416.66	458.33	500.00
	Actual	.....	.....	.....	100	100	100						
Renewals	Estimated	166.66	333.33	500.00	666.66	833.33	1,000.00	1,166.66	1,333.33	1,500.00	1,666.66	1,833.33	2,000.00
	Actual	66.66	175.33	450.99	739.09	850.49	1,088.70						
Depreciation	Estimated	166.66	333.33	500.00	666.66	833.33	1,000.00	1,166.66	1,333.33	1,500.00	1,666.66	1,833.33	2,000.00
	Actual	166.66	333.33	500.00	666.66	833.33	1,000.00						
Producers' Wages	Estimated	2,083.33	4,166.67	6,250.00	8,333.33	10,416.67	12,500.00	14,583.33	16,666.67	18,750.00	20,833.33	22,916.67	25,000.00
	Actual	2,127.66	4,697.50	6,446.90	8,631.57	11,282.21	13,127.60						
Non. Pro. Wages	Estimated	2,083.33	4,166.67	6,250.00	8,333.33	10,416.67	12,500.00	14,583.33	16,666.67	18,750.00	20,833.33	22,916.67	25,000.00
	Actual	2,075.61	4,213.15	6,288.00	8,505.21	10,961.15	12,962.90						
Material & Mdse.	Estimated	6,250.00	12,500.00	18,750.00	25,000.00	31,250.00	37,500.00	43,750.00	50,000.00	56,250.00	62,500.00	68,750.00	75,000.00
	Actual	6,111.96	11,991.91	17,921.20	23,911.35	30,071.90	36,429.10						
General Expense	Estimated	833.33	1,666.67	2,500.00	3,333.33	4,166.67	5,000.00	5,833.33	6,666.67	7,500.00	8,333.33	9,166.67	10,000.00
	Actual	891.75	1,741.50	2,684.25	3,495.75	4,304.50	5,256.25						
Stable and Hauling	Estimated	41.66	83.33	125.00	166.66	208.33	250.00	291.66	333.33	375.00	416.66	458.33	500.00
	Actual	42.75	89.40	132.30	162.84	231.90	281.94						
Printing and Stationery	Estimated	25.00	50.00	75.00	100.00	125.00	150.00	175.00	200.00	225.00	250.00	275.00	300.00
	Actual	23.50	51.50	75.00	96.20	131.00	146.40						
Freight and Express	Estimated	41.66	83.33	125.00	166.66	208.33	250.00	291.66	333.33	375.00	416.66	458.33	500.00
	Actual	49.54	96.49	138.50	185.91	201.92	241.60						
Advertising	Estimated	83.33	166.67	250.00	333.33	416.67	500.00	583.33	666.67	750.00	833.33	916.67	1,000.00
	Actual	83.33	166.67	250.00	333.33	416.67	500.00						
Postage	Estimated	16.67	33.34	50.00	66.67	83.34	100.00	116.67	133.34	150.00	166.67	183.34	200.00
	Actual	17.40	36.70	50.60	61.97	81.38	96.40						
Insurance	Estimated	83.33	166.67	250.00	333.33	416.67	500.00	583.33	666.67	750.00	833.33	916.67	1,000.00
	Actual	83.33	166.67	250.00	333.33	416.67	500.00						
Commissions	Estimated	16.67	33.34	50.00	66.67	83.34	100.00	167.67	133.34	150.00	166.67	183.34	200.00
	Actual	17.00	33.30	41.60	79.40	96.90	125.60						
Interest and Discounts	Estimated	66.67	133.34	200.00	266.67	333.34	400.00	466.67	533.34	600.00	666.67	733.34	800.00
	Actual	79.30	174.60	279.85	394.30	507.21	488.20						
Charity	Estimated	16.67	33.34	50.00	66.67	83.34	100.00	116.66	133.34	150.00	166.67	183.34	200.00
	Actual	16.67	33.34	50.00	66.67	83.34	100.00						
Legal	Estimated	25.00	50.00	75.00	100.00	125.00	150.00	175.00	200.00	225.00	250.00	275.00	300.00
	Actual	25.00	50.00	75.00	101.25	131.25	200.00						
Fuel	Estimated	41.66	83.33	125.00	166.66	208.33	250.00	291.66	333.33	375.00	416.66	458.33	500.00
	Actual	61.40	99.00	142.80	187.94	240.32	282.40						
Contingent	Estimated	83.33	166.67	250.00	333.33	416.67	500.00	583.33	666.67	750.00	833.33	916.67	1,000.00
	Actual	.....	.....	.....	340.90	341.67	467.91						
Total Expenditure	Estimated	13,000.00	26,000.00	39,000.00	52,000.00	65,000.00	78,000.00	91,000.00	104,000.00	117,000.00	130,000.00	143,000.00	156,000.00
	Actual	12,798.67	25,803.00	37,701.06	51,339.04	65,896.79	78,873.83						
Receipts read up.													
Total Receipts	Actual	13,655.73	26,988.73	37,849.79	87,326.73	72,904.71	78,313.66						
	Estimated	13,000.00	26,000.00	39,000.00	52,000.00	65,000.00	78,000.00	91,000.00	104,000.00	117,000.00	130,000.00	143,000.00	156,000.00
140% to Producers' Wages to Balance	Actual	3,679.66	6,980.70	9,780.79	13,661.94	18,189.67	17,901.97						
	Estimated	2,916.66	5,833.34	8,750.00	11,666.66	14,583.34	17,500.00	20,416.66	23,333.34	26,250.00	29,166.66	32,083.34	35,000.00
Producers' Wages	Actual	2,794.36	4,301.97	6,138.36	8,495.74	10,940.91	12,776.91						
	Estimated	2,083.33	4,166.67	6,250.00	8,333.33	10,416.67	12,500.00	14,583.33	16,666.67	18,750.00	20,833.33	22,916.67	25,000.00
25% to Material and Merchandise	Actual	1,918.92	2,779.98	2,937.40	3,799.90	7,986.92	7,792.99						
	Estimated	1,250.00	2,500.00	3,750.00	5,000.00	6,250.00	7,500.00	8,750.00	10,000.00	11,250.00	12,500.00	13,750.00	15,000.00
Material and Merchandise	Actual	6,594.62	13,806.60	17,967.41	25,061.40	30,941.11	36,961.40						
	Estimated	5,000.00	12,500.00	18,750.00	25,000.00	31,250.00	37,500.00	43,750.00	50,000.00	56,250.00	62,500.00	68,750.00	75,000.00
Plant Charge	Actual	391.66	661.94	1,394.66	1,796.22	2,138.74	276.39						
	Estimated	416.66	833.34	1,250.00	1,666.66	2,083.34	2,500.00	2,916.66	3,333.34	3,750.00	4,166.66	4,583.34	5,000.00
Interest	Actual	84.21	79.40	69.97	110.14	156.00	194.64						
	Estimated	33.33	66.67	100.00	133.33	166.67	200.00	233.33	266.67	300.00	333.33	366.67	400.00
Fixed Income	Actual	50.00	100.00	150.00	200.00	250.00	300.00						
	Estimated	50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00	500.00	550.00	600.00

from the $35,000, to make good the deficit, 140% must be added.

We have now a sure method of determining the necessary selling price when the actual cost of material and merchandise, the number of hours and rate per hour, and the tool hours and rate per hour are known; thus, material and merchandise, plus 20%, tool hours at their established rate and labor plus 140% equals the selling price under the conditions assumed in the annual estimate.

But, unfortunately, the business manager cannot sit at his desk in December and predict that his losses for the succeeding year will be $500, and his legal expenses $300, and contingent expenses $1,000, and that he will employ and get the benefit of the product of $25,000 expended in producer's wages. It is this difficulty that the method now presented meets and overcomes by the use of the tabulated monthly statement, Table II. This is shown in monthly form, but so little labor is involved that the manager may keep in closer touch with his business by using a weekly form. This sheet provides for bringing the actual receipts and expenditures together with the estimated, item by item and month by month, so that a glance will show if any item of expenditure is actually overrunning the estimated, and if any item of receipts is underrunning the estimated, and show it in time for correction. It will also show for any month if the total actual receipts or expenditures vary from the estimated, and which way and how much. This is desirable, for one item may exceed the estimated and be compensated by another, so that the total shall be unaffected. This table is prepared and used as follows: The items—Estimated Receipts and Expenditures, Sheet I.—are divided by twelve, and one-twelfth of each item entered in the column, "Month Ending January 31," and on its properly designated horizontal line, under February, two-twelfths; March, three-twelfths, etc., the amounts being cumulative until at the end of the year or under December they amount to the sum shown in the annual estimate. These spaces may be all filled out as shown for the last half of the year—Table II.

It will be noticed that in the two horizontal lines of totals (receipts and expenditures), Table II., the estimated amounts are always equal. They must be if both ends are to meet. At the end of the first month of the new year actual figures are available and are filled in the proper spaces, and the items and totals for the year, as far as it has gone, are directly comparable with the corresponding estimates; and right here the manager has a chance to earn his salary by managing. This method gives him eleven more chances and eleven months' time for remedies.

Answering the proper objection, that selling prices are not made by ascertaining the value of material and labor and adding a percentage, but by competition, it is nevertheless true that unless the value of material and labor will admit of the addition of the percentages proved to be necessary by the annual estimate, without making the selling price so high as to keep the goods out of the market, then the end of the year will show a deficit. When it is found that a selling price arrived at by this method is too high, the obvious remedy is to reduce the amount (not necessarily the rate) paid for labor or material until they will bear the addition of the necessary percentage without throwing the article out of the market. It is clear that, other things being equal, twice the producing force will require but one-half of the percentage to be added. It is also clear that a reduction in the total expenditure, or an increase in any items of receipts, will reduce the percentage necessary to be added. This gives the manager a definite method of making readjustments, as he obtains results of actual business as the year advances. In this method one assumption is necessary, but it is a fair one, viz., that the employment of a certain number of dollar's worth of productive labor produces a corresponding value of product plus the percentage shown to be necessary by the estimate. The manager must secure this result. In other words, every dollar paid to producers plus the required percentage must be charged to the product (this together with the plant charge and material plus its percentage), must be the real value of the product, sold or unsold, and all things must be adjusted to this end.

A NEW METHOD OF EXTRACTING GOLD from quartz has recently been described in England, and said to have been successfully tried on Australian gold-bearing rocks. It is called the "ore-atomic" system. The rock is crushed to lumps of convenient size, it is then, in a closed chamber, from which air is excluded, exposed to the heat of a furnace, and to the action of water, gas, and hydrogen. The sulphur in the ore is thereby eliminated, as sulphuretted hydrogen, and any oxide in the ore is reduced to the metallic state. After being thoroughly heated the material is suddenly quenched by the injection of cold water. This operation is repeated several times, until the quartz is so softened as to be easily crushed by the fingers, and crumbled into powder. The contents of the chamber are then dumped into a tank, and the gold separated by washing. It is claimed that by this process there is absolutely no loss by "float gold" or by oxidation, and that all of the gold in the ore or rock is recovered.

THE FASTEST TRAINS IN GERMANY, says the "Revue Generale des Chemins de Fer," are the express trains between Berlin and Hamburg. On this 177 miles of line, the grades are very easy and the curves are of large radius. Three trains daily leave Berlin and reach Hamburg in 3 h. 36 m., the average speed being 49 miles per hour, not including a stop of 4 minutes at Wittenberg and another of 1 minute at Friedrichruh. The average speed between these two last stations is 52 miles per hour. The normal train hauled is made up of four heavy "corridor" passenger cars, mounted on trucks, and two baggage cars, on 6 wheels each; the total weight is about 133 metric tons. The locomotive has 4 coupled driving wheels, 6.56 ft. in diameter and is provided with a leading truck. The fastest Austrian train is the "train de luxe," running between Vienna and Carlsbad. The 283 miles is made in 419 minutes, including stops aggregating 40 minutes. Deducting these stops, the average speed is about 44.7 miles per hour; this is very good, as some of the grades are heavy and the curves are sharp. The train weighs 140 tons and the locomotive 80 metric tons.

THE DEEPEST BORE-HOLE IN THE WORLD, says Mr. C. Zurdel, in a late communication to the Industrial Society of Mulhouse, is one of 6,571 ft. below the surface of the soil, made at Paruschowitz, near Rybrick, Upper Silesia. The previous record for depth was the 5,733 ft. hole drilled some years ago at Schladebach, near Leipsig. The later bore-hole was made in a search for coal measures, and 83 seperate seams, some of considerable thickness were penetrated. The hole was 12 ins. in diameter at the beginning and this was lined with a tube about 0.4-in. thick; at a depth of 230 ft., the bore was reduced to 8¼ ins. diameter, and thus continued for 351 ft. At this point the blue marl encountered became so compact that the diamond-drill had to be used and under the action of the water the marl swelled to such a degree that the diameter of the pipe had to be again reduced. The greatest difficulty encountered was the great weight of the boring rods, as the depth increased. Though steel was used, at a depth of 6,560 ft. the total weight of the tools reached 39,155 lbs. Under this weight ruptures of the rods were frequent, and an accident of this nature finally stopped the work; about 4,500 ft. of rods fell to the bottom, and being jammed under a part of the tubing it was impossible to withdraw it. The diameter of the well at the bottom was 2¾ ins. Temperature observations made showed 12° C., or 53.6° F., at the surface, and at the depth of 6,571 ft. the temperature reached 69.3° C., or 157° F. This is equivalent to an average augmentation of heat of 1° C. for every 34.14 m. of depth, or 1° F. for every 63 ft. These figures differ slightly from those obtained in other deep borings. The increase of heat at Schladebach corresponded to 1° C. in 35.45 m.; that at Sperenberg, near Berlin, to 1° C. in 32.51 m.; and at the artesian well of Grenelle, at Paris, which is only 1,797 ft. deep and furnishes water at a temperature of 27.70° C., it is estimated that the increase of heat is equivalent to 1° C. in 31.83 m. The boring at Parnschowitz was commenced on March 26, 1892, and it reached its maximum depth on May 17, 1896, or in 390 working days. The total cost was $18,900, or about $2.85 per lin. ft.

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The rapid destruction of the forest resources of the United States has frequently been pointed out in our columns, and we have long advocated the institution of protective measures to check this destruction. A notable example of the enormous consumption of timber for mining purposes is given in the paper which we reprint in another column, giving details of the amount and cost of timber used in the Comstock mines, of California. From 1870 to 1891, it is estimated that there have been used for the mines and mills 674,765,000 ft. B. M. of timbers and lumber, and 391,070,500 cu. ft. of wood, representing a total cost of $46,072,548. About 200,000 acres of forest have been destroyed to operate the mines, and when the remaining 45,000 acres of timber land and wood land are denuded, the timber supply will have to be obtained at a distance of more than a hundred miles from the mines. Even now the bulk of the supply has to be transported 65 miles by railway and flume. Timber is now growing on the area already denuded, but it is said that nearly a century must elapse before this new growth attains the size required for mine timbers. Certainly this area of new growth should be under government care and protection. The paper contains much matter of interest in regard to the supply and consumption of timber and wood for mines, but its most important lesson is that forest protection is a matter of vital importance for this country.

The importance of securing pure water for cities and towns and of quickly and safely removing it after it becomes fouled by use was never before so fully realized in this country as at present. Massachusetts and New York have for some time past vested in their respective state boards of health a general supervision of this matter, and Ohio not long ago followed their example. The engineering societies of Illinois, together with the State Board of Health and the University of Illinois, have drafted a bill looking to the same end, to be submitted to the coming session of the legislature.

We are heartily in favor of the supervision by state authorities of matters affecting the public health, and we hope that legislation to that end may be enacted in Illinois; but some features of the proposed bill, which are reprinted elsewhere, should be modified before the bill is presented to the legislature, if good results are desired from the law. In the first place, it would be a piece of useless red tape to require the approval of the State Board of Health "before any sewer or extension of sewers" could be constructed. There is not a city of any size in which new sewers are not continually being built. On the other hand, the present draft of the bill requires only that systems of public water supply shall be submitted to the board. It would therefore be possible for any city to alter its water supply and take it from a wholly new source without the approval of the board, which is exactly what it is desired to avoid.

We understand from the information received that the analyses are to be made not only at the University of Illinois, but by members of the staff of the University. This, coupled with the proposed nomination of the engineer by the Illinois Society of Engineers and Surveyors, would be withholding from the State Board of Health the selection of the working force necessary for the contemplated investigations. We suppose the idea is to utilize laboratories already established for the chemical and bacteriological work, and that it is assumed that these laboratories are, or may be, properly equipped with men and apparatus for the proposed investigations. With all conditions as favorable as possible, this plan might work most admirably. We are not in a position to speak of the conditions existing in Illinois, but elsewhere the views of a State Board of Health and those of the professors of a state university might not always agree as to methods of investigation, and provided the former had pronounced and meritorious views on the subject this might be a serious matter. In the same way the engineer chosen by the board from the three men nominated by the Illinois Society of Engineers and Surveyors might not prove, later on, acceptable, perhaps through no fault of any of the parties concerned. In such a case must the board retain him, whether or no, until the expiration of his term? There seems to be a chance for both political and professional strife within the society if this nominating power is vested in it. In short, there can be no reason for vesting the nominating power in a wholly unofficial body, unless the official body or persons in whom such powers are generally vested are incompetent, or false to their trusts. The Massachusetts State Board of Health selects its own engineers, chemists and bacteriologists. The work of that board is universally recognized as a model of its kind, and in magnitude surpasses anything ever attempted in this country or, we think, in the world. It is true that Massachusetts is noted for the high character and ability of the men who serve on its public commissions, but if the commissions in other states are less able is it likely that amends will be made by taking away from them the selection of their own working staff? Under such circumstances, one of three results may be expected: (1) Conflict; (2) the working force will finally be controlled by the commission; (3) the commission will automatically adopt the recommendations of its engineers and other scientific workers, in which case the work in hand might as well be given outright to those who actually perform it, and the useless body abolished.

PRINCIPLES AND POLICY OF ENGINEERING NEWS

It has seemed to us, in perusing some of the letters that we receive from our readers, that many of the subscribers to this journal sometimes fail to make it as useful to them as it might be, because they do not understand its general aims and policy or the system on which some of its various departments are conducted. We have therefore selected this last issue of another yearly volume as an appropriate time to present some statements, the subject matter of which is indicated by the title above.

This journal aims to cover the entire field of engineering. We do not, of course, pretend to claim that within the limits of its space can be published everything of value in current engineering literature; but it is the purpose of its editors to keep in touch with the whole broad field of engineering work and select for publication the best that they find in every department of engineering.

We are frequently asked whether an article on this or that subject is "in our line." The answer is that all articles on subjects connected with any department of engineering are directly "in our line," and whether they will be acceptable or not depends solely on the editors' judgment as to their interest and value to the readers. All such contributions, from any source whatever, the editors are always pleased to receive. They are examined as soon as time permits, and such as are found unavailable for use in any form are returned to the senders where such a return is requested.

An opinion as to whether an article on a given subject is likely to prove available is given on request; but the final acceptance of an article can in no case be made until the complete manuscript with illustrations, if any, is submitted.

In general, the receipt of matter offered for publication is not acknowledged, unless this is especially requested. Losses in the mails are so rare that it is not deemed worth while to incur the additional labor of such acknowledgment.

In the case of contributions found unavailable and returned to the sender, the editors have found it impossible to state by personal letter the reason which influence their decision. A printed letter accompanies such manuscripts in which it is explained that the return of the article does not necessarily imply that it is lacking in merit or interest, as the amount of matter offered for publication is so large that a rigid selection has to be made and many articles of merit have to be returned.

We may note in passing that this printed note recently brought us an indignant letter from a "scientist," who had offered us a manuscript in which he upset(?) a well-known engineering formula that has been in universal use for half a century. We quote from it verbatim, for our reader's entertainment, the following interesting passage:

> The return of my paper by means of a printed blank, looked to me so mean and insulting that I concluded, to avoid being reminded of the insult, by henceforth considering "Engineering News" as non-existant. * * * * It is hard for an old scientist, to have his work judged of in private by newlings, but harder yet to have it done by printed blanks. The rudeness of it must make enemies unless my nature is all different from that of others.

We regret to be considered "non-existant," and our curiosity is great as to what a "newling" may be. For the reasons above stated, however, we shall continue the use of the printed blanks and run the risk of making enemies of "old scientists" like the one just quoted.

What has been said with reference to the offer and return of articles above, applies, of course, especially to papers which are submitted for publication and for which their writers expect compensation; but the general principles apply also to all classes of matter sent to us. We are frequently asked, for example, what our position is with reference to what are commonly known as "trade write-ups." The same rule applies to this as to the other matter, that the first consideration is the interest of our readers. We fully recognize the fact that outside what is commonly known as "civil engineering," the great bulk of the engineering work that is carried on in this country is done by manufacturing firms. It is to these that we have to look chiefly, therefore, for a great deal of matter of interest and practical value to engineers; and we welcome contributions from such firms on the same basis as those from any other source. If a manufacturer has a new machine or device of interest to engineers, and will furnish us such drawings and particulars concerning it as will enable an engineer to form a judgment as to its merits, we can often prepare an article from it that will be of great practical value to many of our readers. On the other hand, the manufacturer who sends us a cut of a machine which shows nothing except what a wood engraver imagines its external appearance might be, and a so-called description which, in reality, is only a string of vague generalities concerning what he considers its merits, has no cause for complaint at our decision that such matter is not of sufficient interest to our readers to warrant us in giving it space.

A department of this journal which we believe is much appreciated by our readers is that of "Letters to the Editor," and its development during the past two or three years has been a source of much gratification to us. We intend this department to be a place for the open discussion of any and all matters of interest to engineers, and it is our intention to conduct it with entire impartiality, and to permit free expression of contributors, whatever their views or opinions may be, provided their letters come under our rule above stated, i. e., that they are matter of interest to our readers.

It often happens that letters sent to us for publication criticise the work of some person or firm,

and in such cases, where the letter is found to be worthy of publication, it is our practice to submit an advance proof to the party who is criticised and afford him an opportunity to make a reply in the same issue in which the criticism appears.

In the case of such a discussion we expect those taking part to observe the usual courtesies of debate and to refrain entirely from personalities.

Contributors either to this or other departments of this paper are at liberty to veil their identity under a nom-de-plume if they choose; but in writing to us, must give their real name; otherwise the waste basket yawns for their contributions.

We sometimes find some misapprehension as to the degree to which the editors assume responsibility for the matter published in various departments of the paper. While the matter published on the editorial pages, and, in fact, all matter not signed or credited to some source, may be understood to be prepared by the editors; the contributed matter and the matter taken from the proceedings of engineering societies represents the views and opinions of those to whom it is credited, and not necessarily the opinions of the editors. Of course, all such matter has been examined by the editors, and has been judged by them to be of sufficient interest to be worth publication; but it does not follow that they approve or agree with the ideas or opinions which the writer may express. In the department of "Letters to the Editor" especially, it is our aim to give a fair field to all who have something to say that is worth saying, whether it coincides with our own opinions or not.

In thus defining the extent to which the editorial responsibility extends, we should not be misunderstood as magnifying the importance of the editors' opinions. The editors are well aware that they are far from infallible, and that they, like the rest of mankind, are prone to err. In fact, they are probably better aware how far their work falls short of the standard which they have set for themselves than are any of their readers. But they are at least conscientious in adhering to the principles they have laid down of impartiality and constancy to the interests of their readers and of the profession which it is the aim of this journal to serve.

The change which we inaugurated two years ago, of separating the Construction News and the other matter which is of little value for binding for permanent reference from the main part of the paper, has, we believe, been generally acceptable to our readers. With the first number of the new year a further change will be made in this department, and this eight-page supplement, which is now printed separately, will be bound with the advertising pages. It is our intention also gradually to change the arrangement of these pages so that eventually all the contents of this supplement will be printed on right-hand pages, while the opposite or left-hand pages will be filled with advertising matter. One reason for making this change is that it will enable us to add extra pages to our Construction News department on weeks when there is a surplus of matter, which we cannot now do, except at considerable expense on account of difficulties in connection with the binding. We find also that many of our readers make a practice of cutting up their Construction News supplement, and when the pages are backed with advertisements they will be able to do this without losing the construction news on the back of the sheet.

We believe this arrangement will be especially advantageous also to those who desire to preserve for reference our department of "Contract Prices." These detailed reports of the unit prices bid at contract lettings in all parts of the United States and on all classes of engineering work and materials are of great value to an engineer in preparing estimates. We advise our readers who do not bind their supplements to preserve these items in a special scrap-book, classifying them by materials, and they will find in the course of a year or two that they have a more valuable and extensive record than anything their own note books can furnish.

There is, perhaps, no department in which we are more dependent upon our readers for assistance in carrying out our ideas of improvement than that of "Personals." We wish to make this as complete a summary as space permits of the items of real personal interest concerning engineers of every class; but in order to do this, we must rely on our readers to furnish us the necessary information. What we especially desire is notices of appointments and changes in official position, but space prevents our making note of reelections and reappointments, under ordinary circumstances.

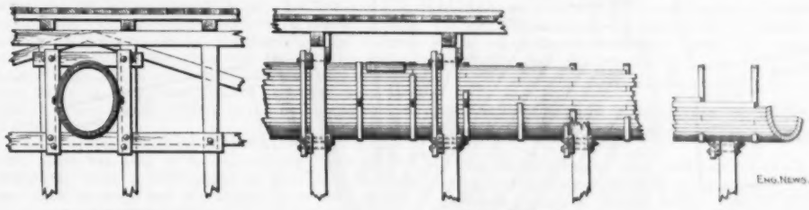
We desire to call especial attention to the use which readers may make of our departments of "Book Reviews," "New Publications" and "Trade Publications." The first of these departments is included in the body of the paper and will be found exceedingly convenient by purchasers of engineering books, who desire information concerning the merits of recently published treatises. Under "New Publications" are included public documents and publications of societies, corporation reports, pamphlets, etc. In nearly all cases the publications noted under this head are for free distribution, and we believe every engineer will be well repaid if he will make it a rule to look systematically through these and the "Trade Publications," and drop a postal card request to the publisher (whose name and address are in every case given) for such of these pamphlets as may interest him. We may say also respecting the trade publications that many of them nowadays contain matter of much practical interest to engineers, and which can be found nowhere else in technical literature. The engineer who does not aim to keep an up-to-date file of the trade catalogues in connection with his particular specialty is likely to be mortified by finding himself ignorant of some technical matter which the commercial man will have at his fingers' ends.

We have reason to believe that most of our subscribers preserve and bind their copies of Engineering News; and, while from one point of view it is of no interest to us what becomes of our issues after they reach the subscribers, in pursuance of our purpose to make this journal of the greatest usefulness to the engineering profession, we would strongly advise our readers to preserve their files complete and regularly bind them for reference.

We are aware that some of our readers pursue the practice of cutting from the paper such articles as are in their especial line, which they file on some system or other, and throw away the remainder of the paper. Perhaps if a man were absolutely sure that he would follow a particular specialty all his life long and would never have need of information on any other department of engineering work, this would be a good course to pursue; but very few engineers can map out their future in that way. Ten years ago thousands of engineers were devoting all their attention to steam railway construction. To-day, nine-tenths of them are in other fields of engineering work, and it is quite safe to say that those fared the best in making the change who were the best equipped for these other lines of work and who had kept in touch with them so far as possible during their work on railway construction.

We would advise our readers, for their own interest, to preserve and bind their files of this journal. The time is very likely to come when the information they can find in its pages on other departments of engineering than that on which they are now engaged, will be of the greatest value to them.

In this connection we are pleased to make an announcement, which will be of interest, we are sure, to those who regularly bind and preserve their papers: At present any one who desires to find all that has been published in this journal on a given subject must search through the semi-annual indexes, and where the search extends over the files of a considerable number of years, the labor involved is considerable. To save this labor in our own office, we some time ago began the preparation of a general index to Engineering News, and its usefulness is so great that it is probable that we shall eventually publish it in book form. The work of its compilation is still in progress and we are not yet able to state positively as to its publication. It is our expectation however, eventually to make it available to our readers, and with this aid, the possessor of a file of Engineering News will have at his hand a cyclopedia of modern engineering progress which will be almost as easy of reference as a dictionary, and which will constitute in itself a completed library of engineering literature.



Cross Section. Side Elevation.

WOODEN BARREL OUTLET SEWER, USED AT NEW YORK CITY.
Horace Loomis, M. Am. Soc. C. E., Engineer in Charge of Sewers.

LETTERS TO THE EDITOR.

Formulas for Bridge Expansion Joints—Corrections.

Sir: In the letter which you published in your issue of Dec. 17 over my signature, the formula $Y = \frac{I}{\cos \beta}$ should read $Y = \frac{T}{\cos \beta}$.

Yours very truly,
F. P. McKibben.

Mass. Inst. of Technology, Boston, Dec. 22, 1896.

Wooden Barrel Outlet Sewers Used at New York City

Sir: There appeared in your issue of Nov. 5, 1896, a description of the wooden barrel sewer as constructed in Brooklyn. This is the same as has been used in this city for many years past. We have found by experience, however, that the construction of these barrels in lengths of say 10 to 15 ft., and putting them together with butt joints supported by cross beams on the piling of the pier is somewhat weak. The impact of large vessels, such as railroad floats and ferry boats, is liable to cause the piers to sway from side to side, opening these joints, and, in some cases, a whole length has been displaced and the barrel collapsed. To obviate these difficulties we think we have improved upon this plan by constructing a continuous barrel, according to the following specifications:

The sewer will be built so as to form one continuous section, each stave will be so placed that there will be a lap of 4 ft. at every stave, and each stave as it is put in place is to be nailed to the next one with 6-in. tinned wire nails, and everything is to be done to make the sewer secure and rigid and to make it impossible for the staves to become loosened.

Under this method of construction the barrel is built continuous, from end to end, as will appear by the sketch which I enclose. This I believe to be a more permanent construction than that formerly employed.

Yours respectfully,
Horace Loomis, Engineer in Charge of Sewers.

New York, Dec. 14, 1896

Dynamite Exploded by Warming.

Sir: It is generally supposed that dynamite will not explode except when used in connection with an exploder cap; in other words, that it will not explode by being ignited by fire. I wish to say that there are exceptions to the above belief.

Some time in October last, while being warmed by an open fire, the dynamite became ignited and thirteen sticks exploded; fortunately no one was near and there were no serious results.

Afterwards a single stick was placed in an open fire as an experiment and it also exploded. There must be a difference in the ingredients used in making dynamite by the different companies, for the writer has often seen dynamite burning where it was being warmed by an open fire.

The above mentioned dynamite was of a black color, "Nonpareil Powder" brand, manufactured by "The Rock Glycerine Co.," of Bradford, Pa.

I am, respectfully,
North Lake, N. Y., Dec. 18, 1896. F. W. S.

[The explosion of dynamite under like conditions is not so rare as our correspondent seems to believe. Warming any dynamite at an open fire is a dangerous operation, to say the least, and that this danger is generally recognized is made evi-

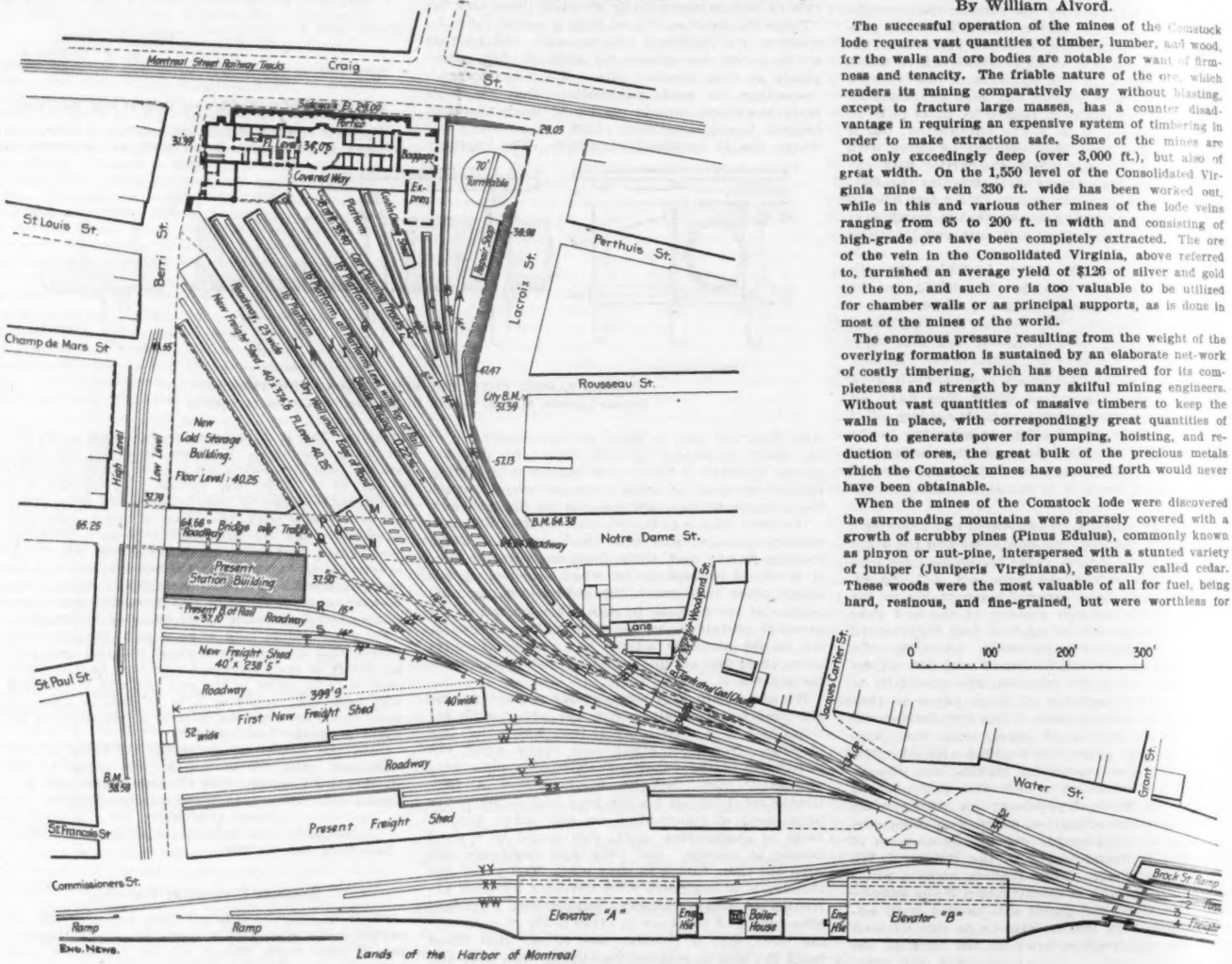
dent by the precautions taken in thawing out dynamite by heated water, sand, etc., in specially contrived vessels. Theoretically, dynamite requires a sharp and sudden shock to explode it, but commercial dynamite is seldom theoretically pure, and we advise caution in handling it when frozen, since accidents are constantly occurring from carelessness in thawing the material.—Ed.)

NEW TERMINAL STATION OF THE CANADIAN PACIFIC RY. AT MONTREAL.

The Canadian Pacific Ry. has at Montreal two important terminal stations, one at the east end and the other at the west end of the city, the only rail connection between which is by a roundabout route outside the city. At the west end of the city is the Windsor St. station (Eng. News, March 3 and 17, 1888), at which is handled all the traffic for the main transcontinental line, the Ontario Division and the south shore lines. At the east end of the city is the Dalhousie Square station, which has a brick station building and no train-shed. At this station is handled all the traffic for the line to Quebec and for several of the small local lines. In the aggregate the traffic is quite considerable and the railway company has for some time been carrying on the preliminary work for a large new station with a headhouse to be utilized for offices and hotel purposes. Additional yard room is also required, the Hochelaga yard being too small and too far away from the terminal. The accompanying plan shows the general arrangement of the tracks, etc., for the new building, being taken from a blue print furnished us by Mr. P. Alex. Peterson, M. Am. Soc. C. E., Chief Engineer of the C. P. Ry.

The present station is situated at the side of Notre Dame St., the offices being on the street level, while the tracks are 27.88 ft. below, the station yard having formerly been bounded by a retaining wall supporting the side of Craig St., and an archway having recently been driven to carry Berri St. under Notre Dame St. at the side of the station. The new station will occupy the entire block bounded by Notre Dame, Craig, Berri and Lacroix Sts., the grade of the ground surface falling away from Notre Dame St. to Craig St., so that the latter is practically on the same level as the present yards. The city gave the necessary authority for the new work, stipulating that a handsome station building and hotel should be built fronting on Craig St. It also gave the land, the railway company giving in exchange land for a small park. The government gave assistance to the project on condition that all trains of the Quebec Division and of the eastern district should run to and from this station. The architect for the headhouse is Mr. Bruce Price, of New York city. The city builds the retaining wall in the eastern boundary of the site, using stone from Terrebonne. Mr. Howard is the engineer in charge of this work for the city.

The first step was to remove the solid ground carrying Craig St. and replace it by a metal viaduct. This work has already been completed, the positions of the piers and columns being shown on the plan. Construction tracks were then laid under this and the grading for the new station was commenced. Of the four main line tracks at Brock St., from which the track system is developed, two (1 and 2) are passenger tracks and two (3 and 4) are freight tracks. Of the station tracks, these marked A to N (inclusive) will be for passenger service, and those marked O to W W will be for freight service. There will be six main tracks (G to L), in pairs, separated by three platforms 16 ft. wide, the tracks rising from the headhouse on a grade of 0.22%, the summit of this grade being reached near the coal chutes. The platforms will be level with the rail heads. The new arrangements will include ample freight shed capacity; a cold storage building, 70-ft. turntable, repair shop, water tank, coal chutes, etc. The grading is being done by the railway company by day labor.



PLAN OF NEW DALHOUSIE SQUARE TERMINAL STATION AT MONTREAL; CANADIAN PACIFIC RY.
P. A. Peterson, M. Am. Soc. C. E., Chief Engineer.

TIMBER AND WOOD CONSUMPTION IN THE COMSTOCK MINES*

By William Alvord.

The successful operation of the mines of the Comstock lode requires vast quantities of timber, lumber, and wood, for the walls and ore bodies are notable for want of firmness and tenacity. The friable nature of the ore, which renders its mining comparatively easy without blasting, except to fracture large masses, has a counter disadvantage in requiring an expensive system of timbering in order to make extraction safe. Some of the mines are not only exceedingly deep (over 3,000 ft.), but also of great width. On the 1,550 level of the Consolidated Virginia mine a vein 330 ft. wide has been worked out, while in this and various other mines of the lode veins ranging from 65 to 200 ft. in width and consisting of high-grade ore have been completely extracted. The ore of the vein in the Consolidated Virginia, above referred to, furnished an average yield of $126 of silver and gold to the ton, and such ore is too valuable to be utilized for chamber walls or as principal supports, as is done in most of the mines of the world.

The enormous pressure resulting from the weight of the overlying formation is sustained by an elaborate net-work of costly timbering, which has been admired for its completeness and strength by many skilful mining engineers. Without vast quantities of massive timbers to keep the walls in place, with correspondingly great quantities of wood to generate power for pumping, hoisting, and reduction of ores, the great bulk of the precious metals which the Comstock mines have poured forth would never have been obtainable.

When the mines of the Comstock lode were discovered the surrounding mountains were sparsely covered with a growth of scrubby pines (Pinus Edulus), commonly known as pinyon or nut-pine, interspersed with a stunted variety of juniper (Juniperis Virginiana), generally called cedar. These woods were the most valuable of all for fuel, being hard, resinous, and fine-grained, but were worthless for timbers and lumber, being too small. They supplied the wants of the mines during the prospecting and surface-mining eras and as long as fuel only was wanted. As soon as any considerable depth was reached, the supply was exhausted and the forests of the eastern slope of the Sierra Nevadas, where accessible, were encroached upon. The forest-line of these mountains has receded westward before the woodman's axe until now it is west of the eastern crest of the Sierra range and almost on a line paralleling the western shore of Lake Tahoe, fairly within the limits of the state of California.

Timbers, lumber, and wood are now principally supplied to the Comstock mines from the southern portion of the Lake Tahoe basin, on the California side of the state line, by the Carson & Tahoe Lumber & Flume Co., a corporation entirely independent of the mines. The

*Abstract of a paper in Vol. X. of the Proceedings of the American Forestry Association.

wood and logs are first transported about twelve miles over the company's railway to the lake shore at Bijou, the railway extending on piles 1,700 ft. out into the lake, to a depth of water where the steamers and barges can moor alongside of the track. The wood is unloaded from the cars on barges having a carrying capacity of from 75 to 140 cords each. The logs are dumped from the cars into the lake and enclosed in boom timbers forming immense rafts.

The company has two powerful steamers engaged in towing these barges and log rafts to Glenbrook, on the eastern shore of the lake. At this point the logs are sawed into timbers and lumber which, with the wood, are reloaded on cars and transported up a long incline to the summit, over another railway, about ten miles long, belonging to the company. At the summit these are unloaded and conveyed through a flume for about twelve miles, to the wood and lumber yards at Carson City, Nev., and from there taken by the Virginia & Truckee R.R. 20 miles to the mines, making a total distance of 65 miles from the forest, over two rugged mountain chains. From the forest to the mines the timber, lumber, and wood are necessarily handled thirteen times.

In the operation of its system the Carson & Tahoe Lumber & Fluming Co. owns and uses 30 miles of railway track and switches, 2 locomotives, 40 cars, 2 steamboats, 6 barges, and 25 miles of flume. This flume is in form of a V, and is provided with all of the improvements which the experience of 20 years in flume transportation have suggested. It has 32 to 34-in. sides, a top width of from 45 to 48 ins., and has a diameter in the bottom of from 5 to 7 ins. It was constructed in 1870, has been in use ever since, and has a reliable supply of water from springs and creeks in the high Sierras. It has a carrying capacity of 600 cords of wood a day, and will transport the heaviest mining timbers as well as lumber and cord-wood.

About 15,000 cords of wood are annually supplied from the forests surrounding the headwaters of the Carson river in Alpine county, California, these being floated down the river in drives during the early summer stages of water. About 8,000 cords a year are consumed in the mills along the Carson river, and the remainder is shipped by rail to the Comstock mines. At present, 120,000 acres of the Sierra Nevada's choicest forests around Lake Tahoe and 75,000 acres around the headwaters of the Carson river have been denuded to operate the mines. When it is considered that this area equals an expanse of land 305 miles long by one mile wide, it will be apprehended that there is good reason for calling the Comstock "The tomb of the Sierras."

Not more than 10,000 acres of timber land and 35,000 acres of woodland are now available to supply the mines. Upon the exhaustion of these it will be necessary to develop the timber regions north of the Truckee river in order to obtain an adequate supply of timbers and wood. This will remove the base of supplies more than one hundred miles from the mines, and will require a heavy expenditure to construct lines of transportation. None of the Comstock mining companies have ever owned or controlled their timber supplies, but have relied on independent companies or individuals for the same.

From Jan. 1, 1880, to Jan. 1, 1891, in all, 249,756,000 cu. ft. of timbers and lumber were shipped to and used in and about the Comstock mines. During the same period 100,776,440 cu. ft. of wood were consumed, and to the latter amount should be added 11,264,000 cu. ft. consumed by the Carson River mills, auxiliary to the mines, making a total of 875,316 cords. These figures are taken principally from the books of the Virginia & Truckee R.R. Co., and may be relied upon. For the decade commencing Jan. 1, 1870, and ending Jan. 1, 1880, which includes the period of development and working of the bonanzas in the Crown Point, Belcher, Consolidated Virginia, and California mines, the timber, lumber, and wood used cannot be ascertained with exactitude, but a conservative estimate by men most familiar with the facts and with sufficient data upon which to base a nearly correct estimate, fixes the figures at 425,000,000 ft. of timber and lumber and 268,800,000 cu. ft. of wood, to which should be added 10,240,000 cu. ft. used in and about the Carson River mills.

In 1870 the timber and lumber sold for $35 per M. ft. at the mines, and wood at $13 per cord, but the prices have gradually fallen since that time, until now timber and lumber are sold at the mines for $22 per M. ft., and wood for $9 per cord. A conservative and probably underestimate of the average price paid at the mines for timber and lumber since 1870 is $23 per M. ft., and for wood $10 per cord.

Summarizing the above statistics, the Comstock mines since 1870 have used 674,756,000 ft. of timbers and lumber, and have paid therefor, at $23 per M. ft., $15,519,388. During the same time the mines and mills have used 391,070,488 cu. ft. of wood, costing, at $10 per cord, the sum of $30,553,160; making a grand total cost of $46,072,548. The pumping machinery of the mines was partially stopped in 1882 and entirely shut down in 1884, which accounts for the much smaller quantity of wood used in the last eleven years than was required for the ten years previous thereto.

The consumption of forest products by the mines for the period embraced between the discovery of the Comstock lode and 1870 can hardly be approximated, as there are no data for that time obtainable, but an estimate that the entire cost of timbers, lumber, and wood used in and about the Comstock mines, from the date of their discovery until the present time, is $55,000,000, could hardly exceed the true amount.

With the exception of the shafts and bulkheads, the prevailing system of timbering in the Comstock mines is that devised by Mr. Philip Deidesheimer in 1860 and commonly known as the "Deidesheimer system." It consists of timbers so framed that when a post is set up there is a place on its top for the ends of four caps, and when these are placed in position a mortise is formed into which the end of the next post fits. The same connections are made with each of the four posts, forming a hollow cube, and there is always a place for the caps of the sets to be fitted on any side.

These sets form cribs of timber 6 ft. square, strengthened by timbers connecting opposite corners in the manner of diagonals of squares. These cribs, when completed, make convenient places in which to stow away waste rock, and make the whole almost as firm as the original material. These sets are as compact as the cells of a honeycomb, to which they bear a striking resemblance except in figure, and by repetition may be extended in all directions to any distance that may be required. This system of timbering exemplifies the truth of the old adage that "Necessity is the mother of invention," for without it the Comstock miners could do nothing, but with it, the mines can be safely worked to any depth, width, or length. The seeming endless labyrinths of timbers in the Comstock mines when ignited and beyond control make a subterranean fire which burns and smolders for years. Many lives have been lost in the mines by reason of these fires, but none have been recorded as having been lost because of any inherent defect in the timbers or system of timbering.

A large proportion of the timber and lumber used in these mines has been in the constructing of shafts and bulkheads. Many of these shafts are from 2,000 to more than 3,000 ft. deep, and are completely encased in timbers. In the Consolidated Virginia mine there is one bulkhead 300 ft. long, 200 ft. high, and 80 ft. wide, containing 57,650,000 ft. of timbers. Another bulkhead in the same mine is 150 ft. long, 100 ft. high, and 50 ft. wide, and contains 9,000,000 ft. of timbers. There are other bulkheads of smaller dimensions, but containing in the aggregate vast amounts of heavy timbers.

The sizes of the timbers used in these mines vary from the huge pieces 16 ins. square and 24 ft. long to the smaller pieces 8 ins. square, used in cribbing.

The species used consist of yellow pine (Pinus poderosa), fir, (Picea magnifica), and cedar (Thuya gigantea), of which the latter is found in such small quantities as to be hardly worth considering. Fully two-thirds used is yellow pine, nearly one-third fir, and less than 1% is cedar.

In a comparison of these woods, in point of durability, red fir would rank at 100, yellow pine at 90, and white fir at 65. In a comparison in point of strength, red fir would rank at 100, yellow pine at 90, and white fir at about 90. In the generation of heat, they would rank in the order of yellow pine, red fir, and white fir. Yellow pine is a favorite timber with mine carpenters on account of its exactitude in joining. Cedar is inferior to no known timber, not even excepting redwood, for its lasting qualities underground. Yellow pine has been taken from the lower levels of these mines so compacted by the enormous pressure it has withstood as to have a density and weight exceeding lignum vitae, and has been made into handsome paper weights and other ornaments.

None of the timbers in the Comstock mines have yet badly decayed, and their life there cannot be accurately determined. The heat and the vapors of the mines, surcharged with mineral matter, appear to have a decidedly preservative effect upon the timbers.

Nearly or quite all of the timber cut for these mines is felled during the winter and spring months; it is flumed during the summer and autumn months, but the timber and lumber are in the water only during their passage through the flume—not more than 75 minutes. Upon being discharged at the mouth of the flume in the yards, the timber is at once piled up in such a way as to prevent warping and cracking and so that the air can circulate freely between each piece. The wood remains until shipped as it is discharged by the flume. As it is built up almost to a level with the flume, the latter is extended so that the wood is piled up by the water in long pyramidal masses about 30 ft. wide at the bottom, 10 ft. wide at the top, and about 20 ft. high; being thoroughly wet when discharged by the flume and drenched as piled, it remains more or less wet for several months and sometimes partially sours. For this reason, flume wood will not generate quite as much heat as will wood which has never been in the water. The effect of the water on timbers and lumber, when handled as herein described, is hardly appreciable.

The area upon which the forest has been cut off to supply the mines is now growing up, principally in pine, but the reproductive growth is so slow that it will require more than a century for the trees to attain a size sufficient to furnish the timbers required by the mines. The new growth is very thick, but as it becomes large the economy of nature, "the survival of the fittest," will kill out the weaklings and leave the stronger young trees at a proper distance apart. On some of the lower slopes of the mountains where the new growth is over 20 years old there are few trees 10 ins. in diameter, and the average diameter will not exceed 6 ins. In the Tahoe Basin, which has been cut over principally within the last ten years, the reproductive growth is about 5 ft. high and will average about 4 ins. in diameter. It is especially noticeable that in the Sierra Nevadas fir predominates on the north slopes where the snow remains the longest and the sun shines the least. On the other slopes pine largely predominates. This indicates that the Sierra fir thrives in a colder climate than is congenial to pine. A further fact is noticeable, that the reproductive growth contains a much larger percentage of pine and a less percentage of fir than the original growth contained. This is satisfactorily accounted for by reason of the sun reaching the ground after the primeval forest is cut off. As the new growth becomes larger and the ground is shaded a larger number of young pines than firs die, but a careful observation leads to the conclusion that when the trees become large enough for use the percentage of pine will exceed and that of the fir be less than in the primeval forest.

The present condition of the mines seems to indicate that the timber available will be adequate to their demands, but if extensive ore bodies should be discovered in the lode, or additional lodes within fifty miles of the Comstock, an enormous expenditure must be incurred to supply necessary forest products.

PROPOSED SANITARY SUPERVISION OF WATER SUPPLY AND SEWERAGE SYSTEMS IN ILLINOIS.

The sanitary supervision and control at all times of all public water supplies, both surface and underground, within the state of Illinois, and likewise the supervision and control of the methods and means of collecting and disposing of sewage is placed in the hands of the State Board of Health by a bill which will be introduced into the Illinois State Legislature at its coming session. This bill had its origin in the Illinois Society of Engineers and Surveyors, and has been drafted by a committee made up of members of that society, the Western Society of Engineers, the State Board of Health and of the Faculty of the University of Illinois. In Sec. 2 of the bill the scope of the legislation asked is given as follows:

> No sewer, extension of sewers, system of sewage (sewerage?—Ed.), or system of public water supply, shall be constructed by any city, village or town in this state, or by any corporation, individual or individuals, until the plans and specifications for such sewer, extension of sewers, system of sewage(?), or system of public water supply, shall have been submitted to the State Board of Health, and received its approval. And in addition to the approval of the plans for the development of public water supplies, the State Board of Health shall examine and cause to be made, analyses of the waters from the source, or sources, of supply, and determine their fitness for domestic and culinary purposes before such waters shall be issued to the municipality, corporation, individual or individuals, signed by the president of the board and attested by the secretary, with the seal of the board.

Sec. 3 of the bill provides that the required analyses shall be made at the laboratories of the University of Illinois, and shall be prima facie evidence of the matters therein stated. Secs. 4 and 5 provide for the publication of rules and regulations made by the State Board of Health under this law for three consecutive weeks in at least one newspaper in each county of the state, and orders that the affidavits of the publishers affirming such publication shall be filed with the County Clerk and shall be conclusive evidence of all facts stated therein. Sec. 6 authorizes the State Board of Health to make such inspections as are necessary to determine whether the terms of the law and the regulations of the board have been violated or not. In case of violation, notice to that effect is to be served upon the violators, and if the fault is not corrected, or good reason shown why such correction is not made, within ten days after service, action may be brought against the violators before any Justice of the Peace in the county where the violation occurred for the recovery of the penalties prescribed, and upon proper showing an injunction may be secured restraining continued violation. Sec. 7 provides that the penalties for violation shall not be less than $50, nor more than $200, for every violation, and an extra penalty of $10 per day for every day the

violation is continued after conviction. Sec. 8 provides as follows:

> The State Board of Health shall, at its annual meeting, each year, elect a sanitary engineer, to be elected from three persons, recommended by the Illinois Society of Engineers and Surveyors, whose duty it shall be, under the direction of the board, to examine all plans for the construction of proposed sewers, extension of sewers, system of sewage(?) and water supply, and to perform such other duties in the line of his profession, as may be assigned to him by the board; to make report to the secretary before the regular quarterly meetings of the board, of all inspections made by him; for which service he shall be paid a sum not to exceed (sum to be specified by the legislature) dollars, to be paid out of the regular appropriations of the board.

Sec. 9 provides for an annual report of the Board of Health to the Governor of the state of all its acts in reference to this law. Sec. 10 provides that the provisions of the bill shall not apply to cities of the first class. The effect of the last provision is simply to exclude the city of Chicago from the jurisdiction of the law. We have commented on this proposed legislation in our editorial columns.

NOTES OF A TRANSCONTINENTAL TRIP.

VII.

Tacoma, Wash.

This is one of the new large cities of the Pacific Northwest. It was first founded in 1868, but its history as a place of commercial importance dates from 1873, when the Northern Pacific R. R. made

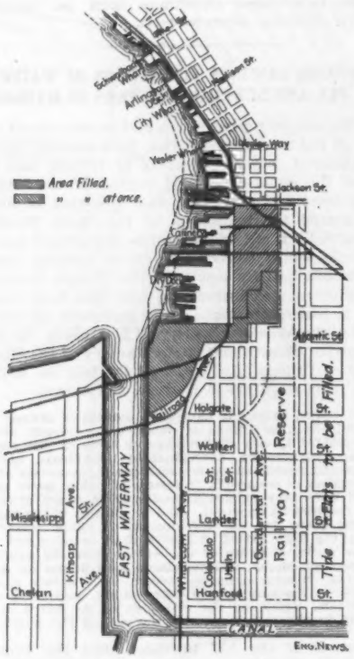


Fig. 1.—Map of Tide-Flat Filling at Seattle, Wash.

this its Pacific terminus. At the time of my visit, however, the city was quiet and business was dull, owing partly to the general commercial depression and partly to the dullness of the summer season. The city is pleasantly situated at the southeastern extremity of Puget Sound, and has fine facilities as a port. The city itself is mainly on high ground, 80 to 100 ft. above the water, but there are extensive mud flats along the shore which are to be filled in for the extension of the docks, wharves and other terminal structures of the Northern Pacific R. R. At Edison, near by, are the new railway car shops, which have cost nearly $1,250,000, while the total cost of the improvements carried out by the Northern Pacific Railway Co. at this point amounts to nearly $6,000,000, these improvements including grain elevators and warehouses of 3,500,000 bushels capacity, and coal bunkers of 22,000 tons capacity, besides two miles of wharf frontage in 30 ft. of water. In June last a contract for a dry dock was awarded by Capt. John E. Higgins to Dougan, Bringham & Cowen, at $86,000, while the repair shops, machinery, etc., will bring the cost up to $1,250,000. The dock will be 425 ft. long, 21 ft. deep, 50 ft. wide on the bottom and 90 ft. wide on the top. There is now a smaller dock, which was built in 1891.

The water supply and electric light plant are owned by the city, and there are about 110 miles of graded streets, 54 miles of sewers and 74 miles of cable and electric railways. Wooden block paving and California asphalt paving are used on the main streets, and plank paving is also used on some streets. The Port Defiance, Tacoma & Edison Electric Ry. has box freight motor cars, which haul ordinary railway freight cars. The population was 36,000 in 1890, and is now estimated at 50,000. There is a smelter here at which 17,000 tons of ore were handled in 1895, the value of the output being $739,150. There is a considerable maritime traffic, including a large percentage of the tea imports (639,042 packages in 1895), and the Northern Pacific Steamship Co. has a tri-weekly service of steamers to China and Japan, while smaller lines of steamers run to various points on Puget Sound and up to Alaska.

Seattle.

This city is about 40 miles north of Tacoma, on the east side of Puget Sound, and a fierce rivalry exists between the two cities. Seattle had a population of 40,000 in 1890, and this is now probably between 50,000 and 60,000. The city is decidedly larger and more bustling than Tacoma, but it is smokier, and not so attractive to the traveler. As at the latter place, great terminal facilities and harbor accommodations are projected, to be built on made land in the shallow water, as the ground upon which the city is built rises steeply up from the water. In consequence of this the approach to the city by rail presents a most singular view. Great areas of open water are thickly dotted with piles, while here and there a roadway or a wharf extends over the piles, and in some cases houses have already been built on a pile substructure. At some distance behind the city are large fresh water lakes, and canals are proposed to connect these with the harbor, the purpose being to facilitate the extensive local marine traffic with places on the lakes and the sound, for Seattle is a great center for local navigation. The city has a considerable amount of brick paving on its streets, and, like all the places of which it is a type, it has a very complete and extensive rapid transit system, the cable and electric lines reaching all parts of the city and suburbs, and extending far into the country. Many of the lines have very steep grades and sharp curves, over and around which the cars are run at high speed, giving the passengers considerable exercise in sliding and swinging about.

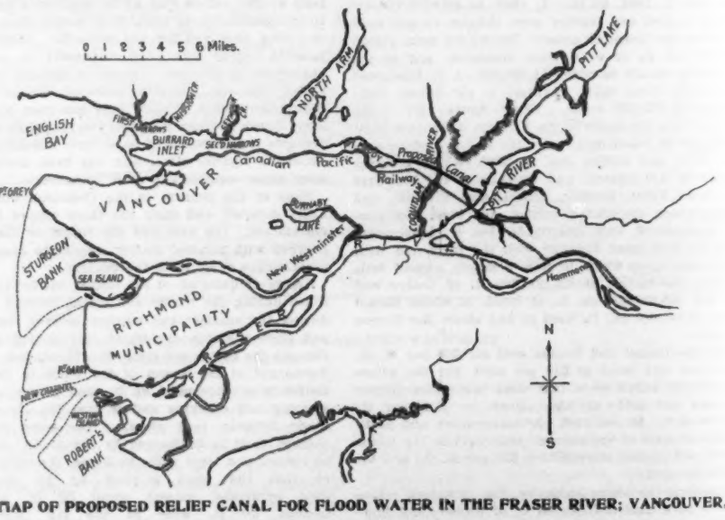


FIG. 2.—MAP OF PROPOSED RELIEF CANAL FOR FLOOD WATER IN THE FRASER RIVER; VANCOUVER, B. C.

Some of the changes of grade are made with such sharp curves that fenders cannot be used, as in rising from the level street intersection to the grades the car platform almost touches the pavement. A new water supply, from Cedar River, is now projected.

The city is not on the Northern Pacific R. R. main line, but on a branch line, which has connections giving a through route to the Canadian Pacific Ry. at Mission, B. C., through trains being run between Portland and Vancouver. There is not a very good railway station, but the Northern Pacific R. R. proposes to purchase a block and erect a large modern station. In view of the large number of transportation interests centering here, and the disadvantages which would result from rivalry in establishing independent stations, yards, etc., the municipal authorities and the Chamber of Commerce have been endeavoring to promote the establishment of a terminal company to provide facilities and accommodations for the joint use of the various railway and steamship lines, thereby increasing the convenience for passengers and shippers and reducing the cost of handling passengers and freight. The railways, etc., would hold stock in proportion to the values of their respective properties in the city, and all details of operation, switching, etc., would be under the control of the terminal company. Another matter of commercial interest at the time of my visit was the proposed establishment of a new line of steamers to Japan, by a Japanese company, and a representative of that company was then on the coast, viewing the various harbors from Victoria and Vancouver, B. C., down to San Francisco and San Diego, Cal. Every coast city, therefore, was pointing out (through its papers and its citizens) its own supreme advantages as the port of such a line, and the adsurdity of the claims of all the other cities interested.

The proposed canals to connect Puget Sound with Lake Washington were described in Engineering News of March 15 and July 12, 1894, and Jan. 24, 1895. There are two of these projects, one of which is being carried on by the U. S. Government, the other by the Seattle & Lake Washington Waterway Co. No appropriation for actual construction of the Government Canal has yet been made. The other enterprise, which is as much a land reclamation project as a canal scheme, is in active progress. A summary of the work thus far done was recently furnished, as follows:

> The company has filled in at present a little less than 50 acres of tide lands immediately adjoining the town. In doing this it has moved over 1,000,000 cu. yds. of sand an average distance of about 4,000 ft., and have dredged the East Waterway for about 2,000 ft. to a depth of 26 ft. below low tide. There are at present two of the largest Bowers hydraulic dredgers at work, and the company proposes to build another in the spring, and also to start work on the hill section part of the canal. The terminal and dock facilities were planned by Mr. V. G. Bogue, M. Am. Soc. C. E., and are shown on the accompanying map (Fig. 1.) They were first considered in platting this part of the tide flats.

Mr. Edgar Ames, General Manager of the company, states that the railways are all to enter along the railway reserve and have their freight houses and yards along this strip. Then along Railway Ave. and Whatcom Ave. there will be tracks with spurs leading on to the docks, so that freight will be handled directly from steamer to car. The east and west waterways will be 1,000 ft. wide, but 448 ft. of this is allowed for lengthening of docks and wharves to accommodate large

ocean steamers. The lock will be 400 × 50 ft., with 32 ft. of water on the upper sill and 16 or 32 ft. on the lower sill at low or high water. The excavation of the big cut will be done by hydraulic giants, the excavated material being conveyed in flumes to the tide flats. The bulkheads for the inner harbor lines have three rows of piles 6 ft. apart, with horizontal timbers, some of these timbers being 9-in. tree trunks, with branches extending back into the made ground. These three pile bents are 12 ft. apart, and a brush mattress filling is placed between the piles.

Seattle to Victoria and Vancouver.

At 10:15 a. m., on July 26, I left Seattle on the steamer "City of Kingston" for Victoria, B. C., a trip of about 80 miles. The "City of Kingston" is a Hudson River steamer, which was purchased some years ago to run between Tacoma, Seattle and Victoria, and was successfully navigated around Cape Horn to its new service on the Pacific. The boat is a screw vessel, built by Harlan & Hollingsworth in 1884. Its trip is mainly in smooth water, but beyond Fort Townsend (crossing the Strait of Juan de Fuca, which connects the sound with the Pacific Ocean) there is something of a sea swell.

Victoria (or Vancouver Island), the capital city of British Columbia, is an attractive city, very pleasantly located, and has a population of about 20,000. The old government buildings are of wood of the Swiss chalet style of architecture, but a large and handsome stone building is now being erected to replace the several old wooden structures. The streets, etc., have a general air of neglect, due, apparently, to a careless and unsystematic administration of municipal affairs, an example of which was brought to light by the inquiry into the terrible disaster caused by the failure of the Point Ellice Bridge in May, as described in Engineering News June 18 and July 2. After the accident, a new steel bridge was proposed, but this was voted down by the council and a plan adopted to build a pile bridge, or trestle, alongside the old bridge, the cost of this to be $5,200. The citizens presented a petition for a steel bridge, to be paid for by the city, the government and the street railway company, but the trestle was adopted as being more rapidly built to re-open communication with Victoria West. As the accident occurred on May 26, and the trestle was still unfinished when I saw it in July (when only a very few men were at work upon it), neither the builders nor the council seem to have been in any hurry to reopen this communication, leaving persons bound for Esquimault to walk across a railway bridge and then walk 1½ miles along a dusty country road to the street car line on the opposite side of the wrecked bridge. So affected was the municipal mind by this disaster, that all bridges and trestles are now closed to street railway traffic, which is a brilliant precaution against accidents. The whole thing seems to have been a dreadful muddle. As to the street railway company, which shared the responsibility for the disaster, it has a most curious and inconvenient way of running its cars, the passengers being liable at almost any time, apparently, to be told that their car does not go any further, but that they must get out and walk on a block or so, where they will find another car. From Victoria, the Esquimault & Nanaimo Ry. extends to the coal mines of Nanaimo, 73 miles, and Wellington, 78 miles, while at Esquimault, two or three miles from Victoria, is the British naval station, with a great land-locked harbor and a masonry dry dock.

On reaching Canadian territory it is interesting to note the difference in appearance, style, dress and accent of the people, which makes it at once evident that this is a part of "Greater Britain," and this difference is accentuated by the scarlet and blue uniforms of the military which pervade the streets, and also by the appearance of the buildings. On the other hand, however, one sees that in all railway affairs American methods prevail, to the exclusion of English methods and practice.

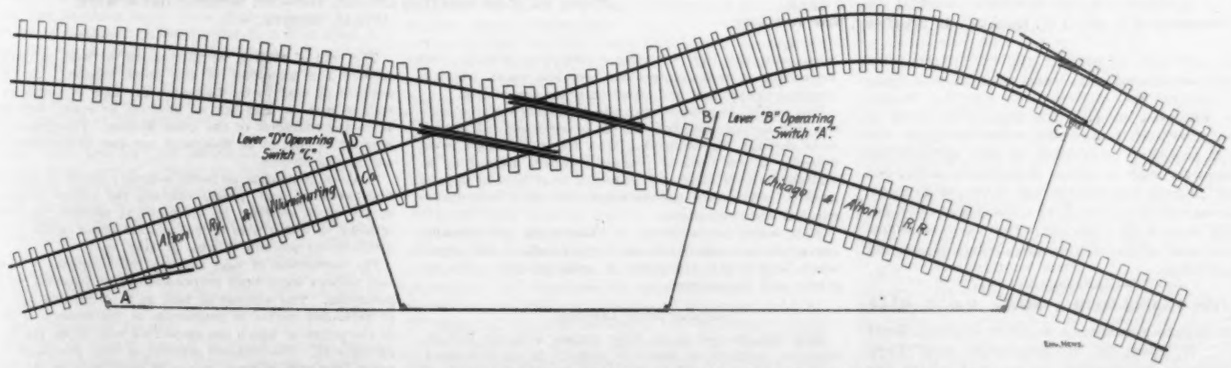
After one day at Victoria, I left at 2 a. m., July 28, for Vancouver, on the steamer "Charmer," of the Canadian Pacific Navigation Co., a vessel built by the Union Iron Works, San Francisco, Cal., in 1887. This northeast trip of about 84 miles was considerably rougher than that from Seattle to Victoria. Vancouver was reached at 9 a. m. (one hour late), the steamer landing at the dock close to the S.S. "Empress of India," of the Canadian Pacific Ry. Co.'s line to Japan and China. The city is small, with a population of about 20,000, but has fine buildings and streets and a general air of prosperity and local pride, which are entirely wanting at Victoria. At the time of my visit it was unusually dull, the mining excitement in the province having drawn away a number of the people. The city was founded in 1886, and a steady commercial growth may be expected for it, as it is the terminal of a transcontinental railway and of two important transpacific steamship lines. The C. P. Ry. has shops and a fine hotel at this place, but in view of the class of passengers and the number of distinguished persons carried by this road, it is strange that a somewhat imposing terminal station has not as yet been built to replace the present small and commonplace wooden structure.

The Canadian Pacific Ry. has two lines of ocean steamers from this port. The fleet of its royal mail line to Japan and China consists of three fine large steamers, which leave every three weeks during the summer and every four weeks during the rest of the year. They are all built to the same plans, being 485 ft. long and 51 ft. beam, and having twin screws driven by triple expansion engines, giving the vessel a speed of over 19 knots. The interior arrangements are very handsome, and the hull is painted white, to aid in keeping the vessel cool in the hot Eastern climate. The other line of steamers runs to Australia (Sydney, New South Wales), stopping at the Hawaiian and Fijian Islands. This fleet consists of four vessels, sailing once a month.

The flat meadow lands along the rivers for some miles east of Vancouver are very fertile, but are subject to inundation by the fierce floods in the Fraser River. To protect these lands a canal is proposed to carry off flood water from the Fraser River, and discharge it direct into an arm of the sea. The project to build a canal between the points indicated on the accompanying map, Fig. 2, is of an entirely private nature, although government assistance has been asked. It is not likely, however, that permission will be granted to construct it without locks, as the wash of gravel into Burrard Inlet would, in all probability, be very considerable and highly detrimental to that harbor. The Minister of Public Works of the Dominion, the Hon. J. Israel Tarte, has been recently in British Columbia studying the whole question of the control of the flood waters of the Fraser River, and it is his intention to send out government engineers to make a careful survey of the channel and to consider the feasibility of diking the banks in a satisfactory manner. Mr. Thomas H. Tracy, City Engineer of Vancouver, states that on the Pitt River, and also on the Fraser River, a great deal of very satisfactory diking has been done by private parties and by the various municipalities. The dikes on the Pitt River, built to reclaim the grazing lands, are from 40 to 54 ft. wide at the base, 12 to 15 ft. in height, and 6 ft. wide on top, and so far they have answered admirably. The British Columbia Drainage & Diking Co. owns about 14,000 acres of the Pitt meadow lands, under a diking concession from the Dominion Government, and has built dikes to protect its land from the flood water.

Mining in British Columbia.

During the past summer there has been a great mining boom in this province, mainly in gold mining, and numerous very rich and valuable properties have been developed, although here, as in all other such cases, many wildcat schemes are founded by unscrupulous promoters. Mr. P. A. Peterson, M. Am. Soc. C. E., Chief Engineer of the Canadian Pacific Ry., and Prof. T. H. Egleston have reported very favorably upon the mineral resources of the province. The iron deposits on Vancouver Island are also being given some attention. Placer mining of gold bearing gravel is being commenced in some districts, and as the province has not yet had bitter experience enough to lead it to adopt legislation restricting the dumping of the debris into the rivers, the mining companies can work for the present with free hands. A less dangerous system is that of dredging the gravel from the river bottoms, and Beatty & Sons, of Welland, Ont., manufacturers of dredging and excavating machinery, have built a complete plant for this work on the Fraser River. The gravel will be raised by a dipper and dumped into a "grizzly," from which the finer material goes to the sluice-box to be treated by quicksilver, while the coarser material goes overboard to a dump scow. Better railway facilities are needed in most of the new districts, and locally there is great dissatisfaction expressed because the Canadians are so slow to provide these, while Americans have invested heavy amounts of capital in developing the resources of the new districts, and have already built lines which divert much of the traffic to points in the United States. The Canadian Pacific Ry. has now some small local connections and steamer lines, but a through line is much to be desired, and this could be afforded by the proposed Crow's Nest Pass line through the southern part of the province. This will not be built, however, unless the government gives the railway company a good subsidy. Mr. Collingwood Schreiber, Deputy Minister of Public Works, has recently visited British Columbia to investigate the actual require-



DERAILING DEVICE FOR PROTECTING STREET AND STEAM RAILWAY CROSSING AT ALTON, ILL.
Paige Iron Works, Chicago, Ill., Builders.

ment for such a line, and the desirability of granting a subsidy. The company has had careful investigations made by its mining expert, with very satisfactory results, and in consequence of this new smelting plants may be erected. The smelting has been done largely by the Kansas City Smelting Co., at Kansas City, Mo., 2,000 miles distant, but the company and the C. P. Ry. Co. will probably put up local smelters for their combined interests. One of the latest new lines is the Columbia & Western Ry. (narrow gage), which was completed from Trail to Rossland this past summer, the contractor being Mr. Henry Blackwood. A line from Vancouver to the celebrated Kootenai district is also projected, and the enterprise has been incorporated by McLean Bros., of Vancouver, as the Vancouver, Victoria & Eastern Ry. & Navigation Co. Another railway project heard of in this province is the British Pacific Ry., which is proposed to run north from Winnipeg, Man., and then westward, north of the Canadian Pacific Ry., touching the latter's branches at Prince Albert and Edmonton.

DERAILING DEVICE FOR PROTECTING STREET AND STEAM RAILWAY CROSSINGS.

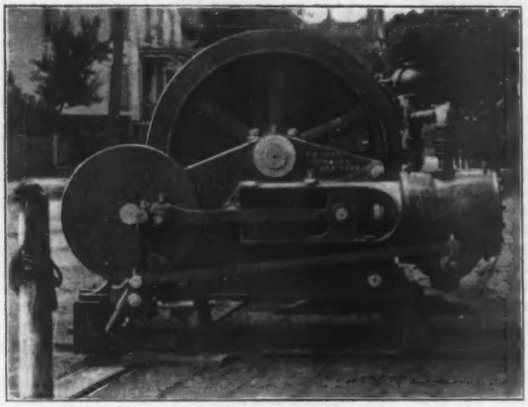
We illustrate in the accompanying cut a derailing device designed to prevent collisions at the crossings of steam and electric railways, which was recently installed at Alton, Ill., at the crossing of the Chicago & Alton R. R. and the Alton Ry. & Illuminating Co.'s tracks. The device is manufactured by the Paige Iron Works, of Chicago, Ill., and as will be seen from the drawing consists simply of a hand operated derailing switch placed on each side of the steam railway tracks and about 50 ft. distant. Normally the switch is open—that is, it is set to derail the electric car, and to pass it the conductor must cross the steam railway track and raise a lever which throws the switch into line by means clearly indicated in the drawing. The lever B opens the switch A and the lever D opens the switch C, and each lever must be held up until the car passes the switch which it controls. After the car has cleared the switch the lever is dropped and the switch is returned to its original open position by means of a spring. The various structural features of the device are clearly shown by the illustration.

A HOISTING ENGINE WITH A NOVEL VALVE GEAR.

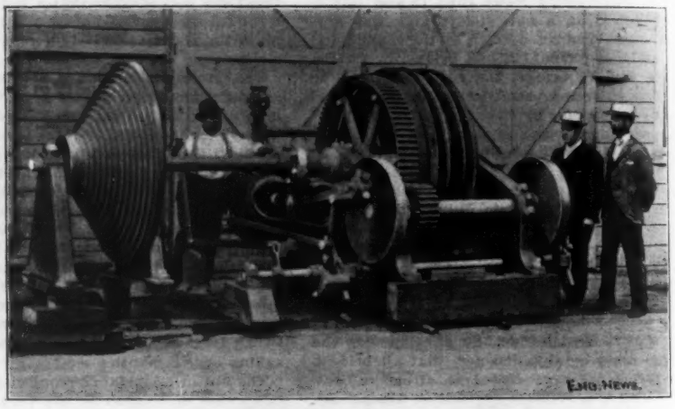
We illustrate herewith a hoisting engine, built by the C. W. Hunt Co., 45 Broadway, New York city, which is noteworthy on account of its use of the Hackworth valve gear, which seems to be especially suitable to this class of engines. It has an overhung eccentric crank, and a rotary valve motion. There are only three moving parts in the valve gear, viz., the valve motion connecting rod, the sliding block and the valve rod. The valve gear is described as follows:

The eccentric is in the same radial line as the crank. The eccentric rod is supported at its lower end by a sliding block, of which the path may be given greater or less inclination, so that the crank end of the rod describes a circle concentric with the shaft, while the other is guided in a straight line by the sliding block. The valve rod is attached to the eccentric rod between the eccentric and the sliding block, and the point of attachment moves in an elliptical orbit, the major axis of the ellipse having the same direction as the path of the sliding block. The sliding block guide being set at a greater or less inclination, the travel of the valve is correspondingly varied, and its inclination being reversed with respect to the center line of the rod, the motion of the engine is reversed.

This device gives constant lead and a better motion of the valve than the link motion, especially at short cut-off. The strains are all in line; the bearing surfaces are all cylindrical or straight, ensuring good work and long service. The motion of the valve is benefited by the rocking of the valve arm, as the effective radius is shorter at the ends of the stroke, consequently the valve has a more rapid motion as its distance from the center line increases. The eccentric rod introduces an irregularity in the motion, and the connecting rod introduces an irregularity in the motion of the piston. The length of the connecting rod and of the valve rod and their relative positions are so chosen as to neutralize each other's irregularities.



HOISTING ENGINE WITH HACKWORTH VALVE GEAR.
Manufactured by the C. W. Hunt Co., 45 Broadway, New York City.



FRONT VIEW OF HOISTING ENGINE, SHOWING WINDING DRUM WITH SPIRAL GROOVE.

CONTRACTION AND DEFORMATION OF IRON CASTINGS IN COOLING FROM THE FLUID TO THE SOLID STATE.*

By Francis Schumann, M. Am. Soc. M. E.**

Introduction.

One of the most serious and annoying difficulties to the iron founder is the tendency of castings to deformation, due to unequal cooling and consequent unequal contraction, excessive initial stresses, if not cracked castings, often resulting, no matter how carefully molded or with what care the iron is selected and manipulated. Our knowledge as to the causes has been but vague, notwithstanding the thought and attention given the subject.

The writer, impressed with the importance of the matter, and having opportunities for observation and experiment through his connection with foundries where great diversity in the form of product resulted, decided to investigate with a view of discovering what laws of physics applied, and in how far the cause and effect were determinable and controllable.

After some twelve years of observation and research the writer is enabled to submit the result of his labors, which it is hoped will prove of practical use to the engineer and foundryman.

General Laws Advanced.

Cast iron, as well as all other bodies, with but few exceptions, expands or contracts equally in all directions, with the increase or decrease of its temperature, respectively. Hence the proportion of a body, whether its temperature increases or decreases, remain alike. At moderate low temperatures, from 32° to 212° F., the change is directly as the temperature. At high temperatures the changes are greater than the changes in heat.

Contraction takes place just when incandescence disappears, or when the color changes from red to black, and continues until the temperature is that of the surrounding mediums.

Contraction and Deformation of Prisms Cast in Sand Molds.

A prism cast in a sand mold will maintain its alignment, after cooling in the mold, provided all parts around its center of gravity of cross section cool at the same rate as to time and temperature.

Deformation is due to unequal contraction of the elements of the cross section surrounding the center of gravity of the section. Unequal contraction is due to unequal cooling, causing, or tending to cause, initial stresses in the elements of the prism, resulting in deformation or rupture.

The rate of contraction between the fluid (heated) state and the solid (cold) decreases with the volume or mass of the casting, and inversely as the time of cooling. Rapid cooling tends to increase the density of the iron; the crystals are diminished in size, and the fracture denotes greater compactness, with more evenness of surface and less ruggedness. The color tends towards white, denoting a change of carbon into the combined state at the moment of solidification. The size of crystals decreases with an increase of combined carbon. Its resistance to impact is lessened, and the rate of contraction is increased.

Slow cooling develops larger crystals, less density, and increased ductility. The fracture is darker or more gray in color, the surface uneven and rugged, and the carbon is in a more free state. The contraction is lessened, and the casting has greater resistance to shock, although its resistance to a quiescent cross-breaking force may be less.

In any prism, variations in density may occur by reason of differences in the rate of cooling, the more rapidly cooling part being more dense, made so by the molecules drawn from the still fluid part of the casting, which, cooling later, will be less dense or with a diminished number of molecules. The molecules in adjusting themselves follow and flow in lines coinciding in direction with the waves of cooling, being from a high to a lower temperature, thus tending to create a void, and lessening the density of those parts which cool slower.

The rate of cooling, or dissipation, of heat, is uniform around the perimeter of the cross section. The total amount of heat to be dissipated per unit of perimeter of section may or may not be uniform or equal, depending upon the character of the cross section. The greater the amount of heat to be dissipated per unit of perimeter the slower the cooling.

A plane of neutral or mean action, relative to the total dissipation of heat, passes through the centre of gravity of the cross section. In symmetrical sections the action is alike on either side of the neutral plane, while in unsymmetrical sections it will, or may, vary.

The dissipation of heat through the perimeter of a section follows wave lines perpendicular, in direction, to the perimeter. The amount of heat to be dissipated per unit of perimeter varies in proportion to the volume or mass of the prism of which the respective unit forms the dissipating side. The relative amount of heat dissipated in a prism, per unit of time, varies in proportion to the dissipating surface of the perimeter divided by its respective volume of cross section.

The crystals that form in cast iron, when changing from the liquid to the solid state, have the tendency, when no disturbing causes interfere, to form themselves into regular octahedrons, or double four-sided pyramids, with their bases joined. Their size varies, the mean increasing with the slowness of cooling. The long axis of the crystals tends to adjust itself perpendicular to the plane of cooling surface of the casting. Thus, in a cylinder, the axis would coincide with the radial lines, while in a square

*Abstract of a paper presented at the New York meeting of the American Society of Mechanical Engineers.

**President Tacony Iron & Metal Co., Tacony, Pa.

prism, the axis of the crystals being perpendicular to the four sides, will tend to flow apart on a plane bisecting the angle of two sides; on this bisecting plane the casting will be less dense and of diminished cohesion.

A prism, unsymmetrical in section, in which the proportion of cooling surface to mass varies around the centre of gravity of the cross section will have the greatest proportion of smaller crystals in the parts cooling the quickest. Where the change in the rate of cooling is greatest will be the place of greatest interference to the natural adjustment of the crystals, as to size and position and hence the place of least cohesion. Contraction is in a direct relation to the rate of cooling, and size of crystals. The more rapid the cooling the smaller the crystals and the greater the contraction.

In any prism, unsymmetrical in section, composed of a smaller mass joined to a larger, the greatest longitudinal contraction will occur in the larger mass. This apparent contradiction to the general law, that contraction decreases with the mass and rate of cooling, is explained when we consider volumnar contraction. The larger mass will have its rate of contraction equal in all directions; the smaller mass is restricted in its contraction longitudinally by the larger mass at the point of juncture of the two masses, but maintains its greater rate of contraction transversely; were the transverse rate the same as that of the larger mass, its longitudinal contraction would be the same, but its transverse rate being greater, the excess in volume flows in direction of length, resulting in a greater length, after cooling, of the smaller mass.

When the rate of contraction in the elements of the cross section of a prism are known, the resulting change in alinement and initial stress, due to the differences in contraction, can be determined.

The line of mean contraction passes through the centre of gravity, or neutral plane, of the cross section. In unsymmetrical sections the centre of action of the maximum and minimum contraction coincides with the centre of gravity of the area elements that are separated by the neutral plane which passes through the centre of gravity of the whole section.

Modifying causes that affect the results obtained by the application of the preceding laws are: Imperfect alloying of two or more different irons having different rates of contraction; variations in the thickness of sand forming the mold, which is the medium for conducting the heat from the surface or perimeter of the cross section; when the prism is cast in a horizontal position, and thin layers of sand at top and bottom affect the dissipation of heat, which becomes unequal by reason of the difference in circulation of air between the upper and under external surfaces of the mold, the upper surface dissipating the greater amount of heat; the position and form of cores, which tend to resist the action of contraction, also the difference in the conducting power between moist sand and dry-baked cores; differences in the degree of moisture of the sand surrounding the prism, especially when small in mass; unequal exposure by the removal of the sand while yet in the act of contracting; flanges, ribs, or gussets that project from the side of the prism, of sufficient area to cause the sand to act as a buttress, and thus prevent the natural longitudinal adjustment due to contraction; in light castings of sufficient length the unyielding sand between the flanges, etc., may cause rupture.

Influence of the Principal Constituents of Iron Upon the Rate of Contraction.

Carbon is the most active element, when in the combined state, to increase the rate of contraction. As strength and hardness result from slight increase in the proportion of combined carbon to that in a free state, it follows that strong irons have a greater rate of contraction than those in which a lesser amount is present. When the combined carbon exceeds certain limits, hardness and contraction increase rapidly and the strength decreases. Increase in the proportion of free carbon has the opposite tendency.

Silicon, when present, not exceeding certain limits, tends to free the carbon, reduces the rate of contraction, and increases the ductility and softness of the iron. Increasing the silicon up to, say, 10%, causes the iron to become brittle, hard, and weak, and increases contraction.

Sulphur tends to change the carbon into the combined state, and hence increases the rate of contraction.

Phosphorus, while tending to harden the iron, has little, if any, influence upon the proportion of combined to free carbon. It lessens the rate of contraction, and diminishes the strength of the iron.

Manganese, as usually present in foundry irons, about 1%, has no appreciable effect. When, however, it reaches 1.5%, and the iron is low in silicon, it tends to hardness and increases contraction, although no alteration in the carbon is affected. In some hard irons the combined carbon is lessened, as also the contraction, by adding small quantities, not exceeding 0.15% of manganese to the molten iron in the ladles just before pouring in the mold. Increased strength also results.

Repeated remelting increases the rate of contraction; it tends to harden the iron, and increases its density. Originally soft mixtures become stronger and harder, while hard mixtures become harder; the proportion of free carbon decreases and the combined increases; the total carbon is slightly decreased. Silicon and manganese rapidly decrease, phosphorus to a less extent, while sulphur rapidly increases, due to the fuel.

Section of Test-Piece.

The cross-sectional area of test-pieces for determining the rate of contraction of a given mixture of iron should increase with the increase of combined carbon contained in the mixture when intended for large castings.

In the remainder of the paper Mr. Schumann develops a practical method of computing the contraction which will take place in any casting and also the initial stresses due to unequal contraction, illustrating the method by numerous examples of which the solution is given in detail. Lack of space compels us to omit this part of the paper, and any of our readers interested in the study of the subject can probably procure copies of the complete paper from Mr. Schumann or from the Secretary of the American Society of Mechanical Engineers. The conclusions with which the paper closes are as follows:

The deformation of prisms due to unequal contraction can be overcome by providing counter deformation in the pattern, or by the addition of auxiliary parts that can be readily removed from the casting. Generally the section should be so subdivided or designed that the ratios of cooling surface to cross section of the piece are alike around the center of gravity of the section.

In complex machinery castings the design should be so modified or chosen that there will result in the least differences in the rate of cooling of the different members. Sudden changes in form cause severe initial stresses, if not fracture, and should be rigidly avoided.

Imperfectly proportioned flanges, ribs, or gussets added to the main body of a casting, either for the purpose of increasing the strength or connections, may be sources of weakness.

Hollow cylindrical columns, although cast of even thickness and left in the mold until cold, may become crooked by reason of the unequal rate of cooling between the upper and lower halves, due to the currents of air passing through the column and clinging to the under side of the upper half after the core arbor is removed, which is usually done shortly after pouring and while the casting is still red hot. This deformation is avoided by stopping the ends with sand immediately after the withdrawal of the core.

Greater attention to the laws of cooling and correct forms and proportions of castings will result in increased strength and economy, besides the avoidance of annoying crooked castings and mysterious breakdowns.

NOTES FROM THE ENGINEERING SCHOOLS.

Michigan Mining School.—The catalogue of the School for 1896-1898 has lately been issued, containing 238 pages. Besides the usual matter in work of this kind, it contains tables giving the classification of rocks and minerals for the use of students taking the course in Geology, Mineralogy and Petrography. The catalogue contains also statistics concerning the mineral production of the United States, and of Michigan in particular. Mention is made of the equipment and work of many of the most important copper and iron mines in the Upper Peninsula.

The storage battery plant which was donated to the school last year by Hon. J. M. Longyear is now being set up. On its completion, the laboratories will have all the supply of current necessary for use in the experiments made. In connection with this work, Mr. Edgar Kidwell, Professor of Mechanical and Electrical Engineering in the school, has developed an automatic circuit make and break switch, designed especially for use with storage battery plants.

Worcester Polytechnic Institute, Worcester, Mass.—The following changes in the faculty are reported: Profs. Geo. I. Alden, head of the department of mechanical engineering; Geo. E. Gladwin, professor of free-hand drawing, and M. P. Higgins, superintendent of the Washburn shop, have resigned. These gentlemen had been with the institute since its opening, 28 years ago, and its present high standing is largely due to their efforts. The first two named have gone into commercial life as manufacturers of direct plunger elevators, a business which has grown up under their direction in the Washburn shops, and which they purchased from the institute. Mr. Gladwin's department was reorganized as a section of the new department of drawing and machine design, now directed by Prof. W. L. Ames, formerly of the Rose Polytechnic Institute. A further resignation was that of Asst. Prof. W. W. Bird, of the mechanical engineering department, who was always a non-resident, and who now devotes all of his time to his iron foundry in Cambridge, Mass.

The new men are: Prof. J. J. Guest, from Cambridge, Eng., where he graduated with high honors and has since been instructor, who comes to take the head of the department of mechanical engineering from McGill University, Montreal; Prof. W. L. Ames, who was mentioned above; Prof. H. B. Smith, from Purdue University, to take the electrical engineering department; Dr. Fred. L. Dunlap, from the University of Michigan and Harvard, recently instructor in chemistry at Sheffield Scientific School, Yale University, occupying the new chair of industrial chemistry; Supt. C. A. Chandler, of the Washburn shops, a past graduate of this institute. New instructors have been appointed in mathematics and in the mechanical laboratory. Prof. Sidney A. Reeve has been appointed to the new chair of steam engineering and hydraulics. He took his degree and was instructor at the Sheffield Scientific School.

Columbia University, New York city.—Plans for the new gymnasium have been completed. It is to occupy about half of a building, to be known as the "University Building," the remainder being devoted to a power house and rooms for literary and other societies. The structure will be three stories high. In the basement will be a swimming pool,100 ft. in diameter and 10 ft. deep,and around the pool will be the shower, tub and needle baths. The principal gymnasium room will be 160x100 ft., 30 ft. high. The total cost of the gymnasium and swimming pool, it is estimated, will be $400,000, and that of the entire building, $800,000.

The Schools of Mines, Chemistry, Engineering and Architecture, of Columbia University, have issued a set of pamphlets, giving general information of the courses for 1896-97. Under the new arrangement of faculties, the Faculty of Applied Science has charge of the four professional Schools of Mines, Chemistry, Engineering and Architecture. In the School of Engineering four separate four-year courses are given, viz., civil engineering, sanitary engineering, electrical engineering and mechanical engineering. The last-named will be offered for the first time in 1897, or upon removal to the new site. Two four-year courses are given in the School of Mines, viz., mining engineering and metallurgy. Candidates intending to enter one of the four professional schools above-named, are advised first to take a four-year course in Columbia College, leading to the degree of Bachelor of Arts, at the same time preparing themselves to enter the third year of either of the professional schools, so that the technical degree may be taken two years later. We take pleasure in quoting the following extract from the pamphlet of General Information, showing how the idea that engineering students should obtain a liberal education before beginning the professional course is being favored by Columbia:

As students may and do enter the college two years earlier than they enter the professional schools, students taking this combined course of study will be able to obtain the professional degree at the same age as though they entered the professional school in the first instance at the present average age of such students, with the added advantage that they will have had at the same time the elements of a liberal education before they enter upon a strictly professional course of study. This combined six-year course is strongly urged and recommended, for the reason that engineers, chemists, and architects, as professional men, need the liberal training offered by a collegiate course quite as much as do lawyers, physicians, or clergymen. Experience has shown that those who have taken a liberal course of study in the past, and who have enjoyed the advantages of such an education before beginning their technical studies, have taken a much higher standing in their profession, have exercised greater influence in the community, and have been much more useful men than those who have relied upon a purely scientific or professional course of study.

Without sacrificing the necessary elements of a liberal education, the widest opportunity for elective work in science is offered in this new curriculum, which will permit the student to pursue almost any desired line of study and to specialize in it to almost any desired extent. A properly chosen course of study in the college will thus fit students for advanced work and original investigation, and is to be recommended to candidates for higher degrees under the Faculty of Applied Science, or the Faculty of Pure Science.

An alternative to the plan of taking a four-year collegiate, followed by a two-year professional course, is proposed in the announcement of the School of Mechanical Engineering, as follows:

It is very desirable that every mechanical engineer should have had a course of liberal and literary studies.

As the strictly professional course offers no time for these studies, students are warmly urged, for their own sakes, to take two preparatory years of such study in Columbia

College before entering the School of Engineering. Special facilities are offered for such a combination of courses. All the alternatives are of equal disciplinary value, so that while retaining the element of strength, the courses thus derive advantage from the flexibility which belongs to the university.

The School of Architecture issues, in pamphlet form, an admirable paper by Prof. William R. Ware, entitled "The Instruction in Architectural Drawing at Columbia University," profusely illustrated and describing his system in great detail. We strongly advise teachers of drawing and any others interested in architectural study to procure a copy of this paper. It was originally published in the "School of Mines Quarterly" for April and July, 1896.

Thayer School of Civil Engineering (Dartmouth College, Hanover, N. H.)—Prof. Robert Fletcher, director of this school, sends us a 12-page pamphlet giving a numbered list of engineering reference books and periodicals used in the schedules of the courses of instruction. In the schedules reference is made by number only. In the list the names of authors are given with the titles, and prices, and the names and addresses of publishers. Books of general value, considered indispensable as part of the equipment of any engineer, have their titles printed in small capitals, and other books of special value, for example, the best, or one of the best, in a particular branch or specialty of engineering, are indicated by an asterisk (*). Such a list as this should be of great value to students in any technical school, and we commend the plan to the attention of engineering teachers generally.

Cornell University.—The new hydraulic laboratory of the College of Civil Engineering has made use of the picturesque gorge and waterfall near the college to construct a rock cut canal 500 ft. long, 20 ft. wide and 10 ft. deep, with a steel stand-pipe 6 ft. diameter and 70 ft. high. This should afford excellent facilities for experimental work in hydraulics.

Ohio State University, Columbus, O.—The Department of Clayworking and Ceramics, which was authorized by an act of the legislature, in May, 1894, is now in the third year of its existence. We quote the following from a circular issued by the Department:

It is the only school on American soil which has made a direct step toward placing the ceramic industries on the same plane as that occupied by the other branches of engineering science and chemical technology. At present the clay-working industries of America, while they enjoy a prosperity due partly to our unrivalled deposits of crude materials, and partly to the mechanical skill and business energy with which they are prosecuted, are feeling constantly the effects of foreign competition, and find themselves at some disadvantage in this contest on account of the wasteful and uneconomic methods used here, and also the very limited extent to which scientific training and chemical technology are employed in counteracting this waste.

Clay industries are essentially chemical industries, and their problems are such as can be readily solved and controlled by the use of good chemical engineering. It is to create such a class of ceramic engineers, men who can apply to the clay industries of to-day the full fruits of the best knowledge of modern science, that this department has been organized and maintained; and it is confidently hoped that the clay industries will co-operate with it in its efforts to achieve present progress, and lead them to ultimate international supremacy.

There are two courses offered: A long one of four years, leading to the degree of Engineer of Mines in Ceramics, and a Short or Industrial Course of two years' duration, which leads to no degree, but for which a certificate of work accomplished is issued.

The four-year, or Engineers' Course, is designed to be complish the objects just set forth, and is therefore made the full equal, both in quantity and quality of the work done, of any engineering course offered by the University.

The two-year or Industrial Course is designed to assist young men who have already been actively engaged in the ceramic industries, and who, on account of mature years, or lack of means, or lack of previous educational advantages, are unable to avail themselves of the full and complete course, and yet who wish to increase their earning power or chances of promotion by fitting themselves for other than routine labor.

Washington State University, Seattle, Wash.—President Harrington has asked the legislature for an appropriation to establish and maintain an engineering department in the University. He says:

It is proposed to provide teachers and apparatus for beginning effective work in civil, mining, electrical and mechanical engineering. The desirability of these lines of professional training in this state need hardly be argued. In our opportunities for marine commerce, in our extensive mineral resources, in the many irrigation problems of the eastern two-thirds of the state, and in even the commonplace and universal problems of highways and bridges, there is more need in this state of all lines of engineering than in most other states of the Union. The estimates provide a very modest beginning for the four lines of engineering mentioned. The proposal is that the new teacher of civil engineering shall also teach mechanical drawing, and the teacher added for electrical engineering shall for a time have charge of the technical mechanical work.

THE BENEFICIAL EFFECT OF WATER METERS at Atlantic City, N. J., is shown by the annual report of Mr. W. C. Hawley, Assoc. M. Am. Soc. C. E., Superintendent of the water-works. On Aug. 1, 1895, there were about 350 meters in use. During the ensuing fiscal year 1,456 meters were added, making about 1,800 in all. The setting of the new meters began in February and was finished July 15. When the work was begun the total pumpage was over 250 gallons per capita per day. The per capita consumption later on is not given, and cannot be estimated by an outsider, Atlantic City being a summer resort. Comparison made be made with 1895, however. This is done in the following table, in which it will be noticed that during the first three months of 1896, or before or during the early part of the meter setting, the consumption was greater than in 1895, and during the succeeding four months of 1896 it was less than in 1895:

	Pumpage, gallons per day—		
	1895.	1896.	Increase or decrease.
January	4,478,440	4,756,238	277,798 +
February	4,427,545	5,060,008	632,463 +
March	4,394,366	5,268,073	873,707 +
April	4,537,553	4,609,964	72,411 —
May	4,776,210	4,642,114	134,096 —
June	5,509,314	4,609,330	899,984 —
July	6,639,762	5,695,708	944,054 —

The cost of the 1,456 meters in place, including valves, fittings and labor, averaged $15.19, the meters ranging in size from 3 ins. to ⅝-in., as follows: 9 3-in.; 6 2-in.; 19 1½-in.; 47 1-in.; 378 ¾-in.; 997 ⅝-in.

THE EXCLUSION OF GROUND WATER FROM A sewer has been effected in a method described by Mr. Robert Godfrey, Assoc. Inst. C. E., in an advance publication of "Proceedings of the Institution of Civil Engineers." The sewer was of concrete, lined with 21-in. earthenware pipe. The defective portion was was 1,320 ft. long, laid in a tunnel through gravel and running sand, 10 ft. deep at one end and 54 ft. at the other, having a grade of 1 in 343. A shaft was sunk 968 ft. from the upper end, there being a manhole at the latter point. Wrought-iron pipe, 12 ins. in diameter and of ⅝-in. plates, was lowered in the shaft in lengths of 14½ ft. Each length of pipe had a special malleable iron collar, which served to connect the lengths by means of lead calking. Two runners were attached to the under sides of the collars to prevent injury to the pipe as the new pipe was drawn through. As one section after another was joined up the new pipe was pulled forward by means of a cable connected to a hand windlass operated by two men. The cable was attached to a bar laid across the end of the lower pipe, thus avoiding strains on the joints which would result from attaching it to the front end of the pipe. The total weight drawn forward after connecting the last length of pipe was about 14 long tons. The pipe was inserted in the 352 ft. of sewer below the shaft and pushed down the grade, as added on, by means of levers. After the new pipe was all in place the annular space between it and the old pipe, at the lower end, was packed with clay and concrete for a distance of 3 ft., thus holding the water back from the stretch of original pipe below. Gagings showed an infiltration of about 35,000 U. S. gallons of ground water in the 1,320 ft. of pipe treated as above, or about 140,000 gallons per mile.

THE NEW YORK STATE CANALS have been reported upon for the year 1896 by State Superintendent Aldridge. The total freight carried in the year amounted to 3,714,894 tons, divided as follows: Erie Canal, 2,742,438; Champlain, 802,510; Oswego, 57,245; Black River, 57,953; and the Cayuga and Seneca canal, 54,739. Of the total tonnage, 852,467 tons were products of the forest, 1,126,665 tons were agricultural products, 152,322 tons were manufactures, 270,603 tons were merchandise, and 1,032,837 tons of unclassified articles were carried. The gain in tonnage over the season of 1895 was 214,580 tons. The average price received by boatmen for the transport of wheat between Buffalo and New York was 3⅜ cts. per bushel, the highest price in any year since 1890, except 1893. The report says that contracts for $3,500,000 have already been made out of the $9,000,000 especially appropriated for canal improvement, and work was commenced on Dec. 1. The Superintendent asks for $770,000 for the next fiscal year, for lock-tending and the ordinary repairs of the canal, which is the same amount that was appropriated for 1896.

THE 20-FOOT NAVIGABLE CHANNEL from Duluth to Buffalo, says Capt. Alexander McDougall, of Duluth, in the "Pioneer Press," is no nearer realization than it was in 1891, despite the work of the government in deepening the channels at St. Mary's River, the Lime Kiln Crossing, at the head of Lake Erie, and at other points. His contention is that since the government engineers ocmmenced these improvements, 10 years ago, the water has fallen 27 ins., as a direct result of cutting a deeper channel through the area of shallow water at the foot of Lake Huron and opposite the mouth of the St. Clair River. He says that, instead of having a deeper channel, we have simply succeeded in maintaining a depth previously utilized. Capt. McDougall is an advocate of the damming of the Niagara River as a means of raising the lake levels.

A NEW FLOATING DOCK FOR HAVANA, says a Madrid paper, has been ordered by the Spanish Government from Swan & Hunt, of Wallsend-on-Tyne, England. This dock is to be capable of lifting ironclads as well as ordinary vessels, and will be 450 ft. long, 82 ft. clear width, and will have 27½ ft. of water over the sill. Its lifting capacity is to be 10,000 tons, and the contract price is about $595,000, to be delivered in complete working order at Havana 11 months after signing the contract.

THE U. S. GUNBOAT ANNAPOLIS was launched at the Crescent shipyard, Elizabethport, N. J., on Dec. 23. It is one of six composite gunboats authorized by act of Congress, July 14, 1895. Three other vessels of this class, the Marietta, Vicksburg, and the Newport, have already been launched. The Annapolis measures 168 ft. on the water line, 200 ft. over all, 35 ft. beam; displacement, 1,000 tons. Babcock & Wilcox water-tube boilers, designed for a working pressure of 225 lbs., will be used. A single screw will be used, driven by a triple expansion engine with cylinders 15¼, 23½ and 36 ins. diameter and 30-in. stroke, developing 800 HP. at 150 revs. per minute. The boat will be barkentine rigged, carrying 11,500 sq. ft. of sail area. The hull of the vessel is built with a steel double bottom, planked with four inches of yellow pine planks to just above the water line. The planks are fastened by manganese bronze bolts, and are then covered by copper sheathing. The stem, sternpost, and rudder are all of bronze, so that no steel is exposed to the action of the sea water in contact with brass. She will thus be able to go on cruises of several years' duration on stations where there are no docks, as she will not have to be subject to frequent scraping of the bottom, as in the case of steel ships. Her large sail area and hull, shaped for easy handling under sail, will enable her to make most of her passages under sail, and to save coal, while her light draught will enable her to visit almost any port.

THE TORPEDO BOAT DESTROYER ENTRE RIOS, one of four boats recently built by Yarrow & Co., London, for the Argentine republic, has completed a voyage from London to Buenos Ayres, making a run of 3,700 miles from St. Vincent to Buenos Ayres without calling at any port. No other torpedo-boat destroyer has ever made a journey of this length without coaling.

A MILITARY TANDEM BICYCLE has been designed by an officer of our army and is illustrated and described in the "Journal of the U. S. Artillery" for November-December by Lieut. Wm. C. Davis, U. S. A. The chief feature of the device is the absence of sprocket and chain. The two riders sit directly over the front and rear wheels respectively, and the crank axles are geared up to the proper speed by a suitable mechanism in a gear-box on the axle. This is a simple epicycle gear, giving two revolutions of the wheel to one of the axle. The front or steering wheel is analogous to the "geared ordinary," and the two wheels are connected by a Humber frame. The gearing is in a dust-proof gear-box, and is oiled through the hollow axle; the frame may be hinged to make it more portable, and the weight of this bicycle need not exceed 40 lbs. for the roughest service. It is designed to carry two riders and 40 lbs. additional weight of equipment. The same article describes a number of bicycles designed for military use in the French and German armies; but all of these have chains.

LOW DUTIES IN THE TARIFF are favored by the Executive Committee of the National Association of Manufacturers. This body met in Philadelphia Dec. 18 and completed arrangements for the annual convention of the Association, which is to be held in Philadelphia Jan. 26, 27, and 28. The committee extends a cordial invitation to all manufacturers of the United States, whether members of the Association or not, to attend this convention; of course only members will be entitled to take part in the debate and the voting. The following resolution was adopted:

"Resolved: That it is the sense of this Executive Committee that the tariff laws should be revised at the earliest possible moment, in order that uncertainty be removed, confidence restored, and business permitted to revive.

"Rates of duties should be made as low as possible, consistent with the fair protection of our industries and the labor they employ."

WAGES AT THE CARNEGIE STEEL WORKS have been fixed to remain in force during 1897, the same as they were in 1895-6. The arrangement affects over 6,000 employes. The prices of pig iron and of finished products have fallen from 10 to 25% since the last scale was signed.

THE RENO INCLINED ELEVATOR has been put into experimental use at the New York end of the Brooklyn Bridge. It is only a small machine, intended to give a practical exhibition of its working, as the elevation attained is only 7 ft., so that passengers using it have still to walk up stairs the rest of the way.

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